POWER

Volume 62 New York, July 28, 1925 *No.* 4

Smoke

SMOKE is a costly nuisance.

It not only pollutes the atmosphere and makes a neighborhood grimy and disagreeable to live in, but it ruins annually thousands of dollars' worth of stock in stores, and rugs, carpets, hangings, pictures and clothing in homes.

There is a lot of talk about smoking chimneys being a sign of prosperity, but most of the processes of industry could be conducted just as well with clean stacks.

The cleaner process would in many cases be less expensive, for smoke is an indication of imperfect combustion, but even if it costs more there is no reason why the populace should pay in extra laundry bills and frequent renewals and general discomfort for the avoidance by industry of the extra trouble and expense required for its suppression.

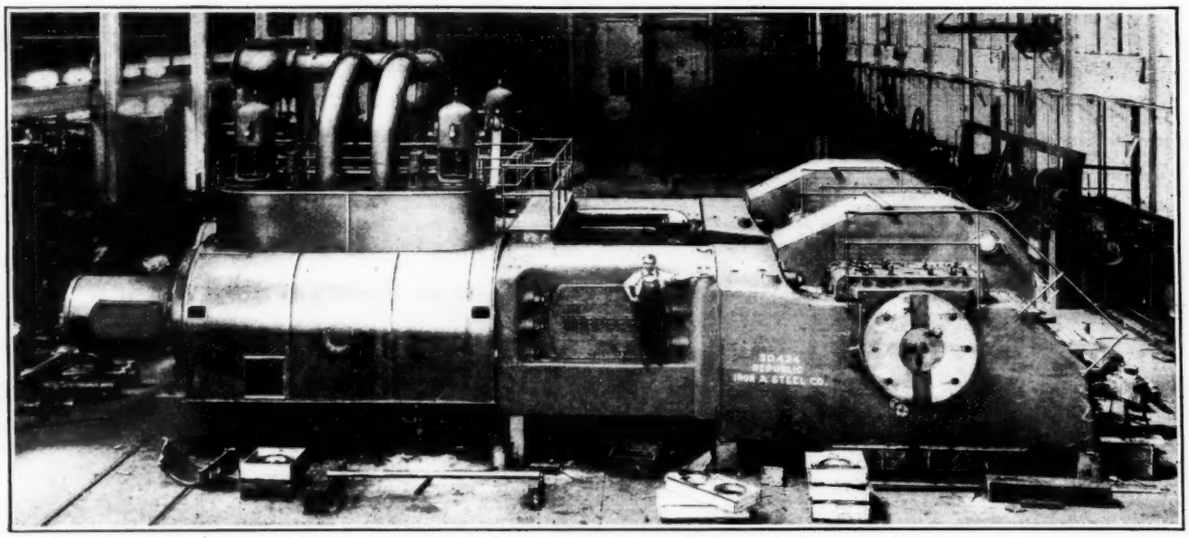
It is probably true, as a general thing, that the owners and managers of fuel-using establishments would be glad to avoid smoke if they knew how, and legislation for smoke prevention has been most successful when it was enforced not in the spirit of the policeman but of the doctor; not by the edict "Thou Shalt Not!" but by the kindly offer, "Come let us see what is the matter;" not by punitive but by preventive measures.

There are many devices available for the improvement of combustion and the burning of even high-volatile fuels without smoke. The automatic stoker, pulverized-fuel systems and combustion-control devices have been developed to real effectiveness.

Many men have qualified as combustion engineers and are competent to prescribe apparatus and alterations and advise with regard to methods for turning smoking and inefficient plants into clean and economical ones.

Is it not worth thinking over?

F. R. Low



Duplex uniflow on the erecting floor

Giant Uniflow Engine for Steel Mill Drive

A 7,500-hp. Duplex Uniflow Engine Installed at Youngstown—Load Varies from 400 to 14,000-hp.—Engine Shipped Within Six Months of Order

THERE is a prevalent belief that the reciprocating steam engine is being installed only in small capacities. This is by no means true, for a number of large steam engines have been built recently. One of the most interesting of these installations is in one of the steel mills at Youngstown, Ohio, where a 60x66-in. duplex uniflow engine has been put in to drive a continuous skelp, sheet-bar and billet mill.

Originally, the steel company had three mills driven by separate engines, and to supply the necessary steam the boiler plants were located conveniently to the engine rooms. After a decision to install a continuous mill, unit drive was necessary. Consideration was given to the proposition of using motor drive, power to be supplied from the mill's main power plant located at one of the steel company's other plants, which plan embraced the installation of additional electric and steam generating equipment. The cost of installing this steam and electric generating equipment, with the conseqent scrapping of the existing boilers that served the three old mills, was prohibitive.

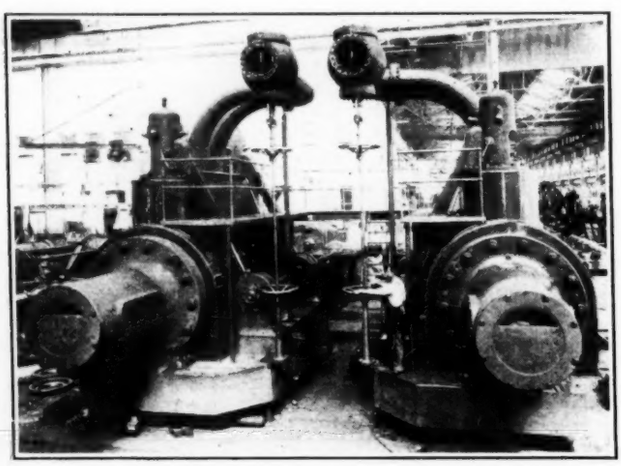


Fig. 1—End view showing how valves are operated

Extreme Fluctuations in Load Made Purchased Power Uneconomical

Purchased electrical energy was also given consideration, especially since the steel company was already using some purchased power, but owing to the character of the mill load, which would vary from 400 to 13,400 hp. per rolling cycle of 112 seconds, making a low average demand compared to the demand peak, this plan was found uneconomical and was dropped. The plan of installing a uniflow engine, considering initial investment, operating costs and the avoidance of scrapping existing boilers, worked out as being the most economical. One additional advantage possessed by the uniflow is its steam-consumption curve at fractional outputs; this is much flatter than the curve of the usual four-valve engine.

The contract for the engine was awarded to the Nordberg Manufacturing Co. on Jan. 8, 1924, delivery to be started by the middle of August, 1924. The unit was to be a duplex uniflow engine, having a normal rating of 7,500 hp. at 90 r.p.m. and a maximum rating of 14,000 hp.; the maximum speed was specified as 100 r.p.m.

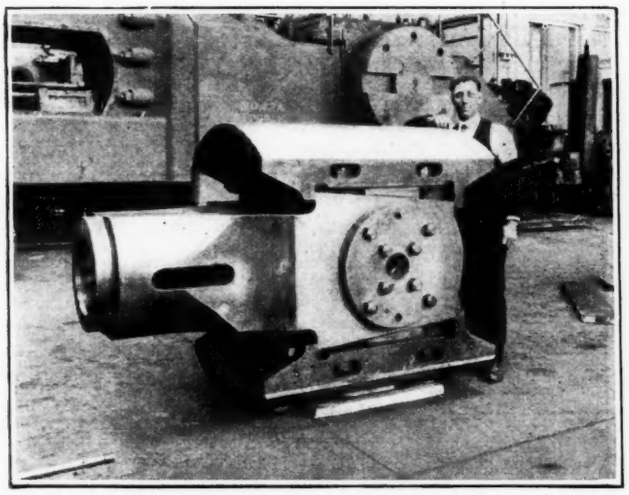


Fig. 2—Compare the size of crosshead with the man

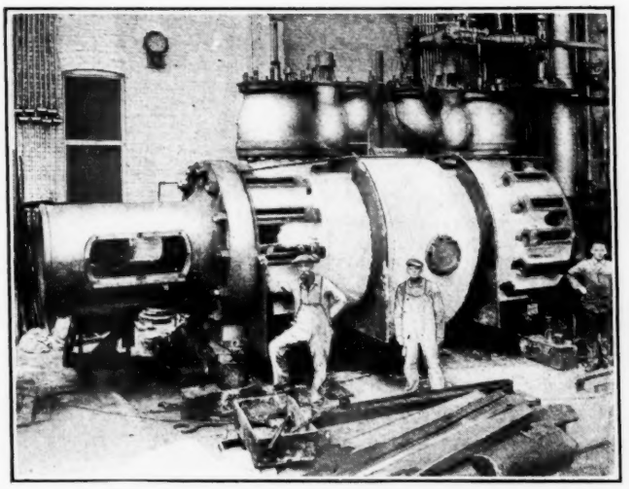


Fig. 3—One side of engine in course of erection

The principal dimensions of the engine were to be:

Cylinders diameter in.	60
Stroke, in.	66
R.p.m., normal	90
R.p.m., maximum	100
Steam pressure, max. lb. gage	150
Steam pressure, min. lb. gage	125
Superheat, present, deg. F.	50
Superheat, future, deg. F.	150
Vacuum to be carried, in hg. abs. pres.	4
Main bearings, diameter min.	26
Main bearings, length, in.	36
Crankpins, diameter, in.	26
Crankpins, length, in.	20
Crosshead pins, diameter, in.	14
Crosshead pins, length, in.	20
Crosshead shoes, width, in.	33
Crosshead shoes, length, in.	50
Crosshead guides, bore, in.	52
Piston rods, diameter in. (hollow)	16
Flywheel, diameter, ft.	20
Flywheel, weight, lb.	180,000

Complete detail and pattern drawings had to be made. Prompt shipment was actually started by July 15 and the unit has been in continuous operation since October, 1924. This record of designing and building an engine of such capacity is remarkable.

In designing the crankshaft bearings and crosshead guides, provision has been made to relieve these members of any tensile stress by running steel rods from the front end of the main frame to the front end of the cylinder. These rods take up the entire frame load when this load produces tension.

The flywheel is between the two frames on the built-up crank shaft, the cranks of which are set at 90 deg. The rim of the flywheel is separate from the arms to which the two halves are secured by fitted bolts. Shrunk links hold the two rim sections and the hub halves are joined by shrunk rings. A drive shaft is coupled to each end of the crankshaft and runs along the roll train for about 265 ft. end to end, including the engine crankshaft. Each set of rolls is driven from this shaft by bevel gears and a cross stub shaft.

Each cylinder is built up of three castings, the cylinder proper and two valve chests which carry the four operating steam valves and the over-compression relief valves. The cylinder has no footing of its own, but is supported by the frame and by the tail guide: this avoids all distortion due to expansion of the cylinder. The tail guide is as shown in Fig. 4, supported by truck wheels using a 42-in. gage track embedded in the foundation. It is comparatively easy to withdraw the piston rod by unshipping the guide and rolling it along the track. The front cylinder heads are removable through the cylinder bore.

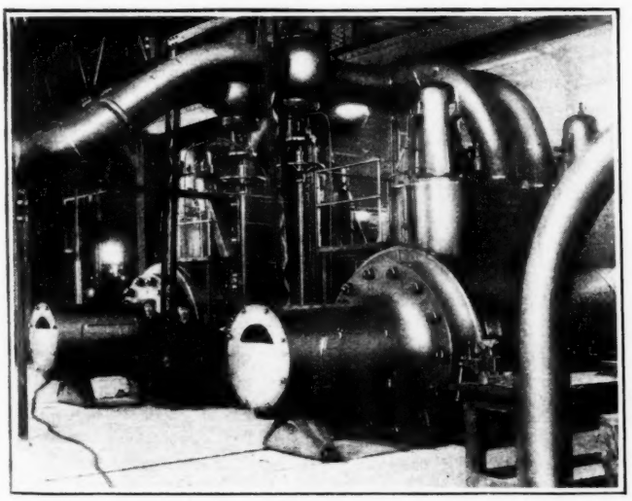


Fig. 4—Engine installed, showing tail rod guides

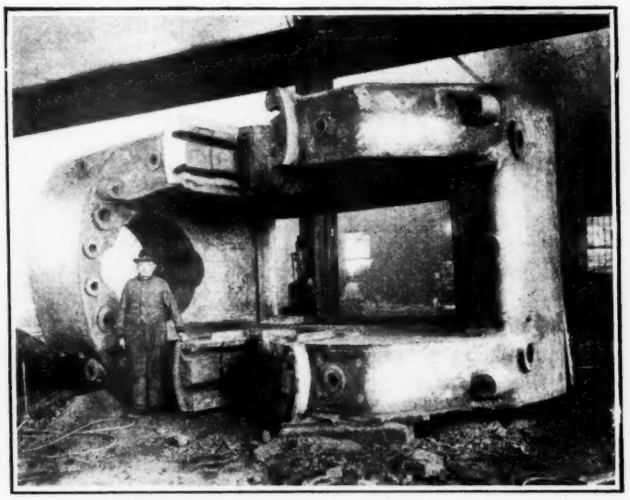


Fig. 5—Each frame is a one-piece casting

The valves are of the poppet type, but are unusual in that four adjustments for new steel edges are provided on the knock-off latches. Special reinforcing bolts are introduced in the ribs of the valve cages to free the cages from tensile stresses set up in the valve seats. The valves are operated by a releasing gear, and while opened mechanically the valve is disengaged from the lifting mechanism at the desired point through the governor mechanism, and the valve closes under spring action. The valve rods are driven by separate eccentrics mounted upon an inclosed layshaft running alongside the frame, there being a layshaft for each cylinder. These layshafts in turn are driven through spur gears by intermediate shafts which receive motion from the crankshaft by means of bevel gears.

In order to keep the proper relation between the compression pressure and point of opening of the steam valves, provision is made to permit the main layshafts to be advanced in relation to the crankshaft, thereby changing the lead of the steam valves. For this purpose the spur gears between the intermediate and layshafts are made with inclined teeth, and the gear on the intermediate shafts can be shifted lengthwise while the engine is in operation, thereby retarding or advancing the layshafts the proper amount.

The clearance space is designed so that with the specified vacuum the terminal compression pressure equals the steam chest pressure. In case the vacuum should be partly or totally lost, causing the compression to rise above the steam-chest pressure, the automatic over-compression valves open to relieve the excess compression pressure into the steam chest. The hollow piston rods are hammered open-hearth steel and are proportioned to carry the entire weight of piston and rod on the crosshead and tail guides. The pistons are made of cast steel and are fitted with snap rings and keepers.

Provision has been made to permit the turning of the engine to a definite position for spotting the rolls and for reversing in case of a cobble in the rolls. When this is done, the governors are lifted to the top position by a steam ram, thereby preventing steam entering through the main steam valves. A cam is placed in the cylinder end of the layshafts to operate four poppet valves admitting steam consecutively to the four steam ends of the two cylinders. The position of this cam in relation to the layshaft can be changed so the steam can be admitted to the proper cylinder end for either running ahead or reversing.

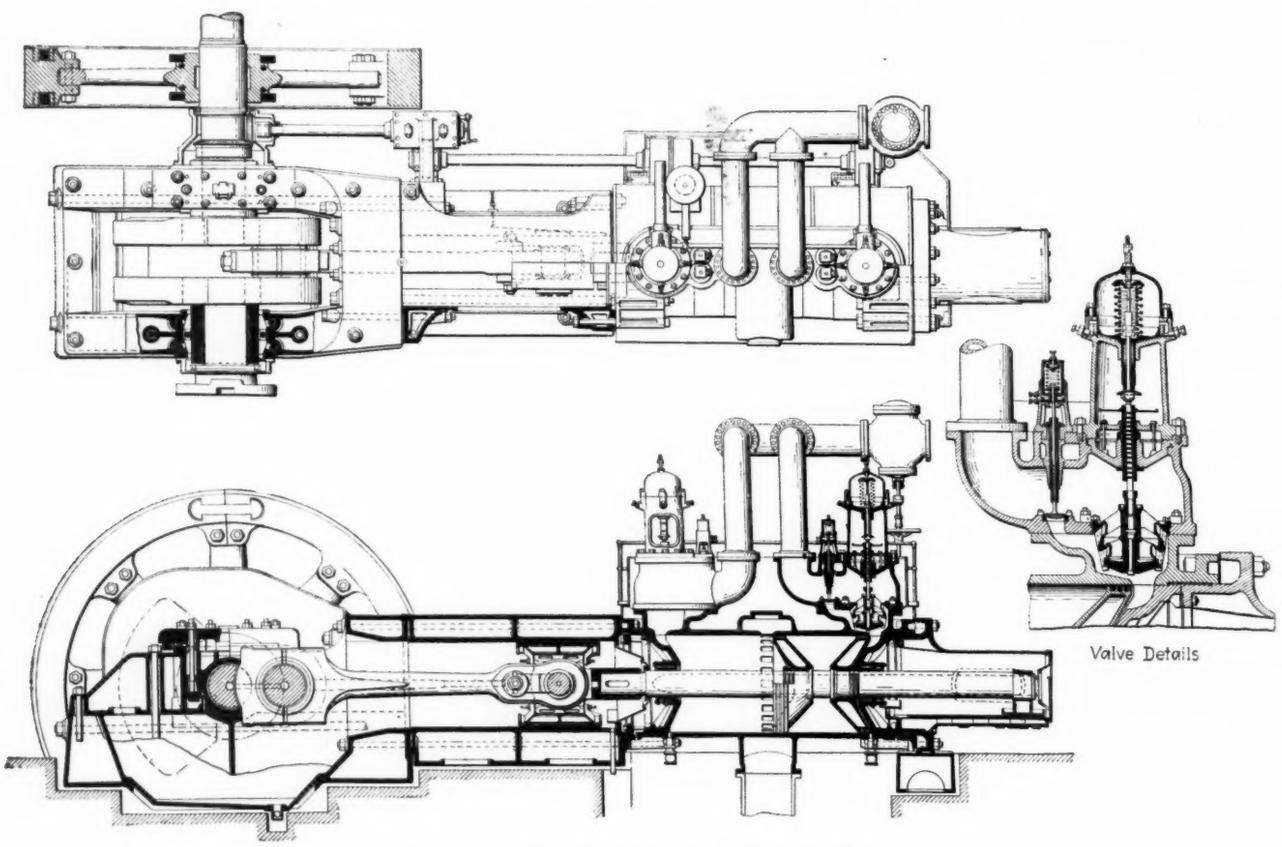


Fig. 6—Plan and cross-section of engine

The engine is equipped with a complete force-feed lubricating system which provides an oil pressure of 5 to 7 lb. per sq.in. in each bearing. The engine oiling system is provided with bag filters and centrifugal separators. All the eccentric, valve gear and governor parts are lubricated by this system, no oil cups being found on the entire engine.

The engine is in the main building. The boiler plants are all connected by steam mains, and the steam supply to the engine was carried overhead on a steel structure. All bends are of the long-radius type. Within the building the steam main is supported on pipe columns carrying springs at the top to allow for any slight deflection in the pipe that might be produced by temperature changes. The steam pressure is 150 lb. gage with 50 deg. superheat at the throttle.

Condensing water is obtained from the Mahoning

River and contains much sediment and some acid. Consequently, a surface condenser was deemed inadvisable and a barometric unit was installed. The boiler feed is cold treated by an intermittent lime-soda softening process. All boilers are equipped with steam purifiers.

A slate instrument board with main steam-pressure recording and indicating gages, steam-temperature recording gage, separate cylinder-pressure indicating gages, recording vacuum gage, indicating mercury column reading vacuum in inches of mercury automatically referred to 30-in. barometer and r.p.m. indicator and recorder are provided.

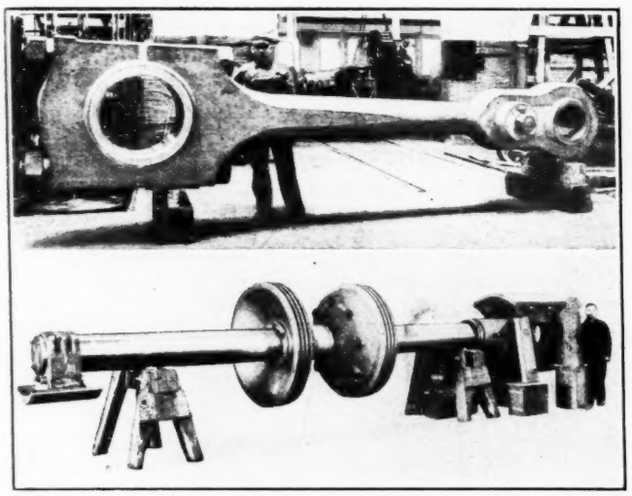


Fig. 7—Upper view: The connecting rod has a babbitted steel crank-pin box and a phosphor-bronze crosshead box. Lower view: Shows the two piston heads on the 16-in. hollow piston rod

The operating crew consists of one engineer and helper, also an oiler on the oil purifying system, per turn.

Feed-Water Regulation Makes Boilers Safer

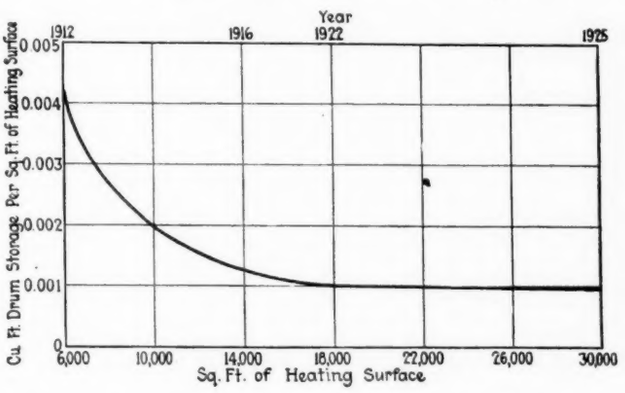
A brief review of a few cases will illustrate how feed-water regulators have, in emergencies, prevented accidents that would have occurred had not the boilers been so equipped.

A few years ago a fire broke out in the boiler house of the McTurk Coal Co., at Girardsville, Pa. The men stayed in the building and fought the fire as long as they dared, but finally the flames forced them out. In the excitement there was no opportunity to flood the boilers. Believing that the boilers were sure to explode, the men fled to a near-by hill to watch. The fire continued until the building burned down, but there was no explosion. The boilers were saved because the regulators kept in operation until the furnace fires had gone down. The insurance company saved a lot of money that would have been lost had the plant depended on hand regulation of the feed water.

A little over a year ago a fire broke out in the plant of the California & Hawaiian Sugar Co. The only water available to fight the fire came from a pump inside the burning building. At 11 p.m. the men were forced to leave, but continued to fight the fire from the outside, and by 7 a.m. had put it out. Two agencies saved the day here. One was the automatic fuel-oil feed which kept the boilers steaming for hours after the men had left. The other was the feed-water regulators, which continued to supply the right amount of water to the boilers so that the pump was kept in operation. Here again the insurance company saved many thousands of dollars that would have been lost had the plant depended on water tenders.

In the early days of feed-water regulators, the objection was frequently heard that the use of regulators would cause the boiler-room attendants to become careless. Each year this objection has become less frequent. and it is now seldom heard. It is generally agreed that a simple and sturdy mechanical means of regulating the input to boiler-feed water, given a reasonable amount of supervision, will contribute greater safety to boiler operation than where the whole job is dependent on manual control. A check-up on a long list of boiler accidents has demonstrated that the failure of the human element has in practically all cases been responsible for the accident.

In the last few years, too, a new condition has arisen which accounts for a great increase in the use of feed-water regulators. Boilers of today have a much smaller water-storage space per rated horsepower than those of ten to fifteen years ago. This means that much greater care must be taken in feeding. Short periods of overfeeding cause high water and engine-room trouble. Even short periods of underfeeding cause low water and boiler trouble. The limits within which guessing could be done have been greatly reduced. With these sensitive boilers the best of water tenders have the greatest difficulty in keeping the water in the glass. Basically, this is due to the fact that the water tender must wait until after a visible change in water level has taken place before he acts to adjust the feed-water supply.



The new large boilers have proportionately less water storage. This necessitates more sensitive feed control.

This recognition of the marked advantages of feed-water regulators over hand control is general among operating engineers, especially those who have had experience with both automatic and manual operation. These men insist that the plants under their supervision be equipped with regulators because of the greater reliability and protection thus afforded. The boiler insurance companies, who are just as concerned in the safe operation of these plants, also should recommend the installation of feed-water regulators.

Latest Design and Practice in Power Plants

IT IS shown that the heat units per kilowatt-hour have been reduced from about 22,500 in 1913 to less than 14,000 in 1925. The study also indicates that although the cost of coal per unit of power is decreasing, there is a decided increase in the fixed charges.

PROGRESS in the art of steam-station design and operation has been so rapid as to bewilder even the men who are giving their whole time and thought to this work. We have grown quite accustomed to seeing our dreams become actualities almost over night. The past year has witnessed the actual generation of power in an 80,000-kw. generating station at a coal rate per kilowatt-hour 20 per cent lower than any previous performance on a commercial scale, so states the report of the American Institute of Electrical Engineers Committee on Power Generation, presented at the annual convention June 23, 1925, at Saratoga Springs. After calling attention to a number of factors that have been influential in improving the efficiency of steam plants and pointing out some of the results that have been accomplished in a number of modern plants, the report goes on to say[1]:

Recent progress made in steam power-plant design may be visualized by reference to the address delivered by W. H. Patchell at the time of his inauguration as president of the British Institution of Mechanical Engineers, Feb. 21, 1924. As a result of a review of the situation in this country and abroad, Mr. Patchell presented the operating efficiencies for thirty-six stations in England, twenty-five in the United States and one—the Gennevilliers station—in France. The heat units per kilowatt-hour for the most efficient station in England were given as 20,150 B.t.u., for the most efficient station in the United States 18,030 B.t.u., and for the Gennevilliers Station in Paris 22,240 B.t.u. The remarkable performance of the Philo Station of the Ohio Power Co., which went into operation this year, has been as low as 13,715 B.t.u. per kilowatt-hour.

Trend of Steam Power-Station Performance

These facts may be visualized by reference to the curves in Fig. 1, which show the trend of performance of typical stations plotted against the dates of initial operation of these stations. This curve represents the weighted average of the performances plotted for twenty-two stations. At first glance, the curve appears to have a peculiar shape. Further analysis indicates that there was a definite reason for the slowing up of power-station development during the war period, and the high prices of coal during the period from 1920 to 1922, inclusive, in no small measure account for the marked improvement in the performance of stations that have gone into service within the last six months.

The dotted extension of the curve shown in Fig. 1 is an estimate as to the future possibilities in the way of improved performance for a station designed to operate on the straight-steam cycle with a single stage of reheating. Obviously, this curve has to flatten out. There is shown at *A* the over-all performance for a combined mercury-vapor and steam station, which is indicated by the performance of the mercury-vapor turbine and boiler in the Dutch Point Station of the Hartford Electric Light Co. The dotted curve is an estimate of the future possibilities of the combined mercury vapor and steam cycle.

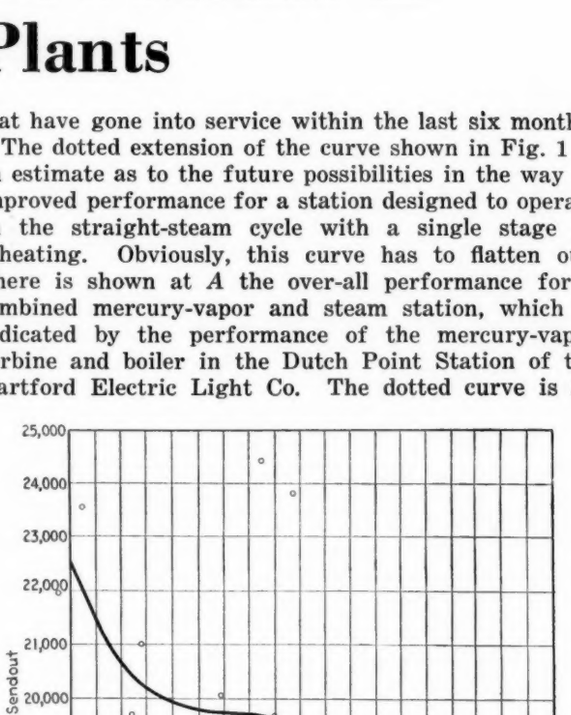


Fig. 1—Trend in performance of steam-electric stations rated at 60,000 kw. and higher

One might well gain the impression that the possibilities for further improvement in steam-station design have been almost exhausted. This fact is hardly the case. There are at least three major possibilities immediately ahead which will result in higher operating efficiencies for steam-generating stations:

A. The further development of commercial equipment for use in the application of the mercury-vapor-steam cycle.

[1]See Report of A.I.E.E. convention on page 1045, June 30 issue, for more details concerning modern steam-plant performance.

B. The development of superheaters, high-pressure steam piping, valves and turbines for operation in connection with steam temperatures of 800 deg. F. or higher.

C. The use of hydrogen or some equally suitable gas as the cooling medium in connection with closed ventilating systems for turbo-generators, and the development of new generator designs which will take advantage of all the possibilities of this new cooling medium.

Possibilities for Future Improvement in Steam-Plant Performance

It is true that while there has been a drop from approximately 18,000 B.t.u. per kw.hr. to 14,000 in the last eighteen months, a further reduction from 14,000 to 10,000 B.t.u. per kw.-hr. cannot be looked for unless use is made of the mercury-vapor-steam cycle, with comparatively high pressure used in connection with the mercury-vapor boiler and the most efficient possible layout in connection with the steam end of the station. As far as further reduction in the fuel cost in connection with large steam stations goes, work is being done on the law of diminishing returns. A point has already been reached where further gains are going to be quite difficult of attainment.

The real function of power-station engineers is to deliver power on the station busbars at the lowest possible cost per kilowatt-hour. The total cost per kilowatt-hour delivered on the station busbars is made up of four major elements: (a) Operating labor and superintendence; (b) maintenance; (c) fuel cost; (d) fixed charges on the investment.

The so-called operating costs generally referred to when power costs are discussed, is made up of items a, b and c. Accounting systems commonly used do not spread fixed charges so as to allocate so many mills to each kilowatt-hour generated, and accordingly many lose sight of them. It is obvious that the interest and the taxes paid in connection with an investment in power stations and the money that must be set aside each year to provide for renewals due to depreciation and obsolescence are as tangible elements entering into the cost per kilowatt-hour as the money that must be paid for fuel to generate that same kilowatt-hour.

Fig. 2 shows the trend of operating costs and fixed charges of typical large power stations plotted against the dates of initial operation for these stations. As in Fig. 1, only power stations of 60,000-kw. capacity and higher are considered. An endeavor has been made to take into account all the different factors in the derivation of these curves.

Fuel Costs and Fixed Charges

The thing that stands out from an inspection of the curves in Fig. 2, is the relative trend of the fuel cost and the fixed charges during recent years. There has been a marked reduction in fuel cost due to the improvements in power-station design and the declining price of coal. There is a definite upward tendency, however, in connection with the fixed charges per kilowatt-hour, and at the present time the fixed charges are 4.5 mills per kw. as compared to a fuel cost of 2.4 mills per kw. For stations located in closer proximity to the coal mines and having the advantage of lower coal costs, the fuel costs will be still further reduced, assuming the same modern power station design. The fixed charges, however, will remain at 4.5 mills.

The indications are that if we strive for lower fuel costs by the use of more efficient stations, the fixed charges per kilowatt-hour will rise still higher, and the increase in fixed charges per kilowatt-hour will more than offset the decrease in fuel cost per kilowatt-hour.

The real job which the power-station engineer has ahead of him is to decrease the fixed charges per kilowatt and re-establish the proper balance between fuel costs and fixed charges.

Certain executives and engineers will, no doubt, state that the fixed charges per kilowatt-hour in the

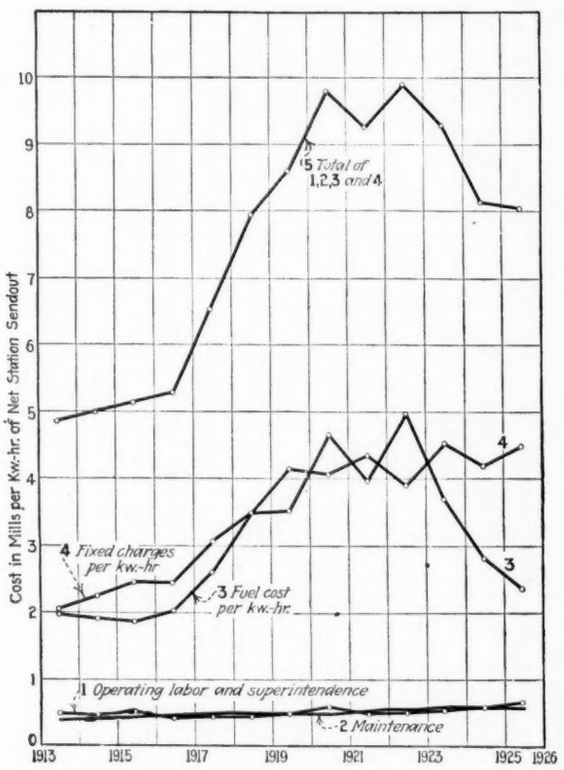


Fig. 2—Trend of operating costs and fixed charges of steam stations rated at 60,000 kw. and higher

newer stations which they are placing in operation, are very much lower than the curve indicates in Fig. 2, for the reason that the newer stations are carrying the base load for their system and are operating at an extremely high use factor. The answer is that each new turbine or station operates on base load only as long as it constitutes the most efficient turbine or station on the system. The curves given in Figs. 3 and 4 tell this story in a striking manner. They show that the generating unit is heavily loaded during the second and third years of its life, but that from then on the loads carried during succeeding years gradually decline. These curves[2] given in Figs. 3 and 4 constitute the actual operating history as regards kilowatt-hours generated during succeeding years by 268 turbines ranging in size from 750 kw. to 60,000.

It is obvious that fixed charges per kilowatt-hour must be determined by taking the total fixed charges on a piece of equipment or on a station during its life

[2]The data given in Figs. 3 and 4 were compiled by the Turbine and Generator Committee, Association of Edison Illuminating Companies, and embodied in the report of that committee for 1923.

and spreading them over the total number of kilowatt-hours generated by that particular turbine or station during its useful life.

It is of interest in Fig. 3, that the average unit capacity factor during the 17-year period on the 268 turbines is approximately 25 per cent. The curve of fixed charges given in Fig. 2 was based on the assumption that for generating stations placed in operation in 1913, the average unit capacity factor during their life would be 31 per cent, and for stations placed in operation in 1925, the average unit capacity factor would be 36 per cent. The evidence would tend to indicate, therefore, that if error has been made, it is on the side of showing the fixed charges per kilowatt-hour too low rather than as too high.

Tendencies in Design

Tendencies in the design of steam generating stations may be classified under four heads:

1. Tendencies that improve the reliability of the power station, increase its cost, but do not appreciably affect the operating efficiency; for example:

a The use of house turbines, auxiliary generators, and storage batteries for insuring the auxiliary power supply.

b. Isolated-phase layout and the use of reactors and other protective devices in the switchhouse.

c. The duplication of auxiliaries, and provision of excessive amounts of spare capacity in boilers and turbines.

2. Tendencies that decrease the coal consumption per kilowatt-hour and increase the cost of the power station; for example:

a. The use of excessively high steam pressure taken together with a single stage of steam reheating during its expansion.

b. The use of pulverized fuel burning equipment.

c. The use of adjustable speed motors for driving

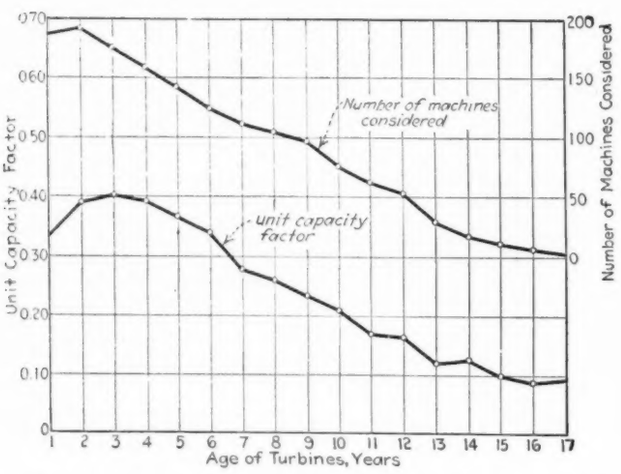


Fig. 3—Unity capacity factors of turbine-generator units

auxiliaries where saving in power consumption at light loads is the consideration.

d. The use of air heaters or economizers usually falls in this classification.

e. The use of an excessively large amount of surface in the surface condensers for the main turbines.

3. Tendencies that decrease the coal consumption per kilowatt-hour and also result in a reduction in the cost of the power station and perhaps in the cost of operating labor; for example:

a. The use of electrically driven auxiliaries.

b. The use of moderately high steam pressures without reheating.

c. The use of the highest steam temperatures which are possible with existing materials.

d. The use of large turbines and large boilers.

e. The use of three- or four-stage bleeding for

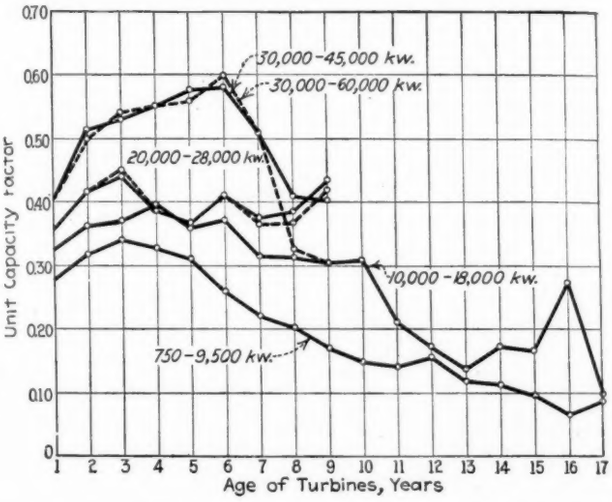


Fig. 4—Unity capacity factors for various sizes of turbine-generator units

raising the temperature of feed water to within 75 deg. or 100 deg. of saturated steam temperature.

f. The use of large mills for pulverizing coal.

4. Tendencies that add to the cost of the station without improving either its reliability or appreciably decreasing its coal consumption; for example:

a. Insufficient care given to grouping of equipment and waste space in power-station building.

b. Too many architectural frills.

For a particular set of operating conditions, some of the examples cited herein as falling in one classification may really classify themselves under an entirely new head. An inspection of the curve given in Fig. 2 presses home the conviction that every tendency that makes for an increase in the cost of steam-generating stations, and correspondingly increases the fixed charges, must be viewed with suspicion. The burden of proof should be on the designing engineer to show why the particular feature should be embodied in the design. The same line of reasoning indicates that the designing engineer should give intensive study to those tendencies of power-station design that hold forth promise of giving lower first costs and lower fixed charges, as well as lower fuel costs.

The value of a thing depends on the need for it. A glass of water might easily be worth one hundred dollars in the desert and practically nothing somewhere else. It is the same with heat. The heat in high-pressure steam is usable in every plant, hence most valuable. That in low-pressure steam is almost as valuable in some and in others much less so. The heat in the circulating water at 80 deg., say, is generally a dead waste although in the future some use may be found for such heat.

Starters for Direct-Current Motors

Manual Type of Starters and Their Limitations—Automatic Types, Their Advantages and Disadvantages—Principle on Which Automatic Starters Operate and the Classes of Service to Which Each Type Is Suited

By R. B. HUNTER
Electrical Engineer, Cutler-Hammer Manufacturing Company

WHEN putting a direct-current motor into service, it must be started and brought up to speed by applying a gradually increasing voltage to the terminals. If full voltage is applied with the armature not rotating, a current of from 6 to 20 times full-load value will flow, depending on the size of the motor. This excessive current might cause injury to the windings of the motor by overheating and possibly by mechanical distortion, damage the commutator, trip the protective devices, cause voltage fluctuations in the supply line, or interfere with other motors and lighting circuits on the same system.

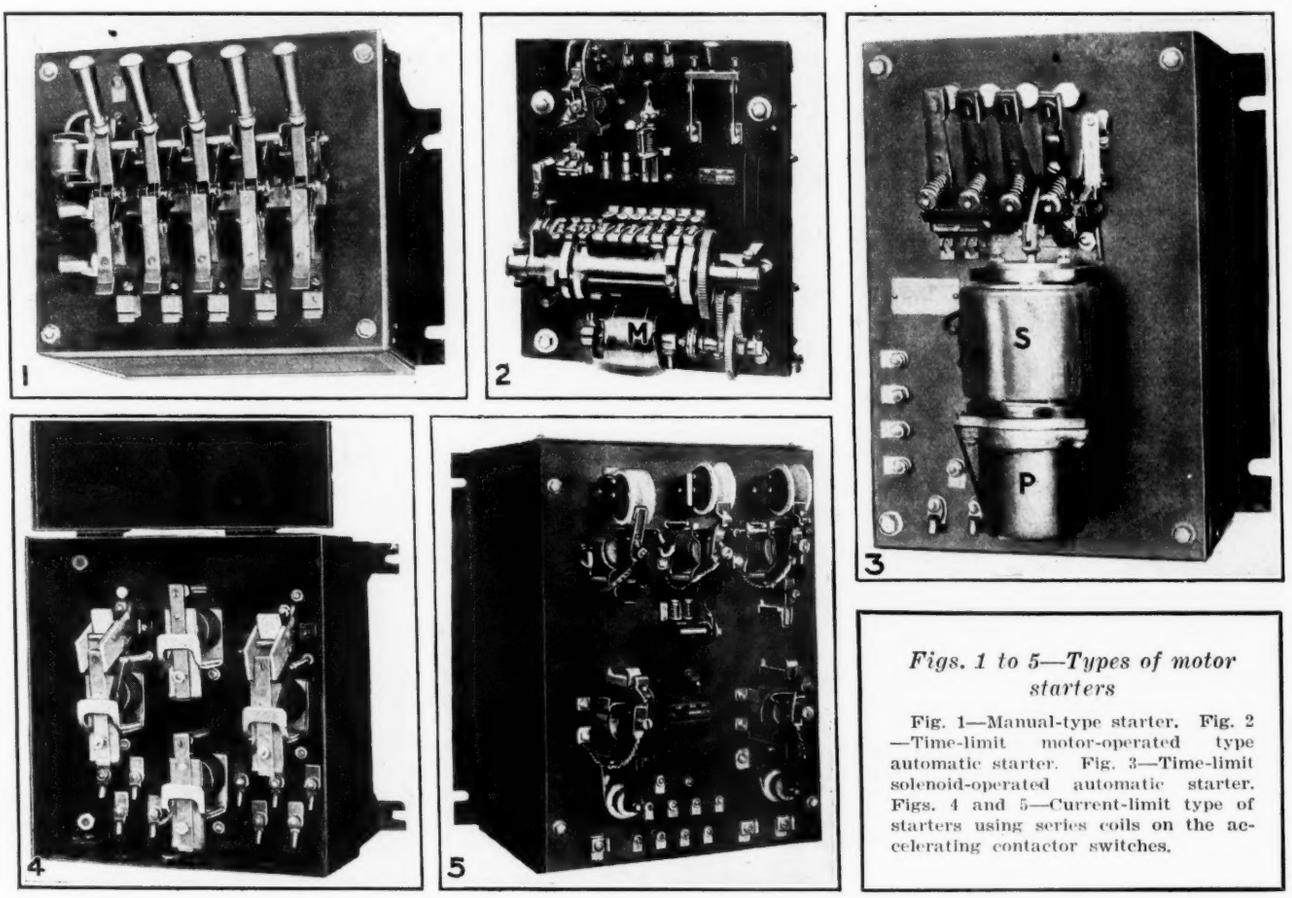
The reduced voltage for starting the motor is generally best obtained by inserting a resistor in the motor circuit at standstill, and gradually short-circuiting this resistor as the motor gains speed. The resistor is usually short-circuited in a number of steps by means of switches. The mechanism used for short-circuiting the starting resistor is known as the motor starter. These starters may be divided into two classes according to the methods of operating the short-circuiting mechanism: (1) Manually operated starters; (2) power operated starters.

A typical manually operated motor starter is shown in Fig. 1. This type is usually cheaper than the power-operated starter, but has the following inherent defects:

1. The rate of acceleration is at all times under the control of the operator, and the motor and starter are consequently subject to abuse which may defeat the objects intended to be achieved by its use. This abuse may be due to ignorance or to carelessness, or to excitement in periods of danger or emergency.

2. Starters for very large motors cannot well be operated manually because of the power required to operate the large switches necessary to handle heavy currents.

3. It also sometimes happens that the time required



Figs. 1 to 5—Types of motor starters

Fig. 1—Manual-type starter. Fig. 2—Time-limit motor-operated type automatic starter. Fig. 3—Time-limit solenoid-operated automatic starter. Figs. 4 and 5—Current-limit type of starters using series coils on the accelerating contactor switches.

to operate a manual starter militates against its use. It may be that the starter must be operated at a time when several other things must be done, in which case a power-operated starter that can be operated by pushing a button or set in motion by a float-operated switch, is desirable.

Power-Operated Starters

The power-operated starter must in some manner introduce a time element between the closing of the successive resistor short-circuiting switches; such starters may be divided into current-limit type and time-limit type.

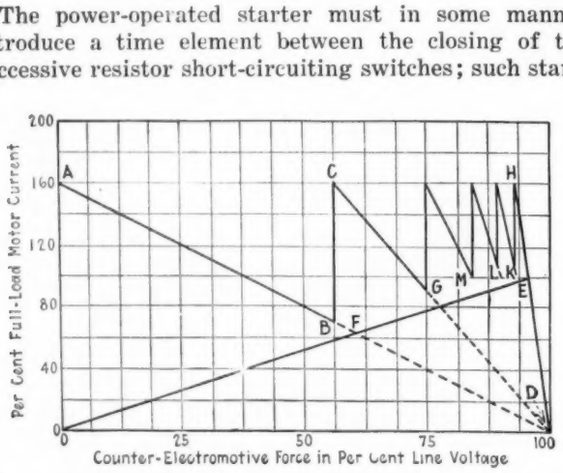


Fig. 6—Diagram showing acceleration of motor driving an unloaded generator

Time-limit starters may be motor driven, in which case the time element may be secured by the inherent speed of a small pilot motor *M*, Fig. 2, which, through a speed-reducing gear, actuates the resistor short-circuiting switches shown just above the motor. Time-limit starters are also frequently actuated by means of a solenoid which lifts a plunger to which the short-circuiting switches are attached (see Fig. 3). The action of the solenoid *S* is retarded by a dashpot *P*, and the time required to close the switches can, therefore, be adjusted according to the nature of the load to be accelerated.

When current-limit control is used, each resistor short-circuiting switch is operated by means of a separate electromagnet. The first magnet is energized by a push button under control of the operator, and the current which flows to the motor is limited by the resistance in series with the armature. This current is indicated by the vertical distance *OA* in Fig. 6. As the motor accelerates, the counter-electromotive force increases and the current in the armature circuit decreases along the line *AD* until the point *B* is reached. A relay consisting of an electromagnet wound with heavy wire is connected in the motor circuit; the armature of the relay is released when the current has fallen to the value indicated by *B*, completing the circuit to the electromagnet which operates the next switch. This short-circuits a portion of the armature resistor; the current rises to the point *C* and then falls again. As the counter-electromotive force increases, the current decreases along the line *CD* to the point *G*, when another relay releases its armature to complete the circuit to a third magnetic switch, and so on until all the starting resistance is cut out of circuit.

Instead of relays wound with heavy wire and connected in the armature circuit, use is sometimes made of relays wound with fine wire connected across the armature brushes. These relays are set to close at certain values of counter-electromotive force, thus short-circuiting sections of the resistor in the manner previously outlined. This type of starter is usually known as the counter-electromotive-force type.

In the preceding paragraphs it has been assumed that the decreasing current or increasing counter-electromotive force acts on relays the contacts of which close the circuit to electromagnets which in turn operate switches, short-circuiting the resistor. It is, however, entirely possible to make the change in current or counter-electromotive force operate the short-circuiting switch directly as is done in the starters, Figs. 4 and 5.

Constant-Time Starting of Motors

The disadvantage of constant-time acceleration of motors is that the timing device (either dashpot or motor) may not be adjusted so as to cause the short-circuiting switches to close at the period corresponding to the proper condition in the armature circuit. The worst condition arises if the armature is blocked so that it cannot accelerate. The timing device will cause the switches to close at fixed intervals, so that an excessive current will flow, unless the counter-electromotive force increases as the resistor is cut out of circuit.

The disadvantage of the counter-electromotive-force method of acceleration is that the resistances of the coils, which are connected across the armature, may change owing to the temperature coefficient of the material with which the coils are wound, so that they do not always close at the same value of counter-electromotive force. All known zero-temperature coefficient materials have a high specific resistance so that a coil wound of such material is inefficient. Consequently, copper is the universally used material for such coils and an increase in resistance of 20 per cent between maximum and minimum temperatures is not uncommon. This fluctuation in resistance, combined with fluctuations in line voltage which sometimes occur, may result in the failure of some of the switches to close, and the resistor may be left in circuit for an indefinite

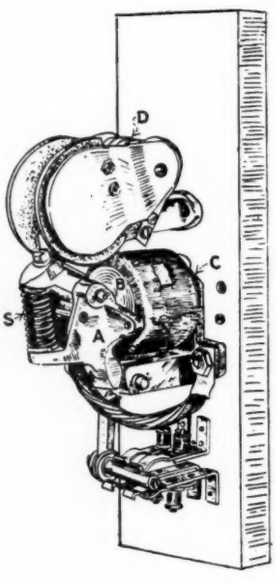


Fig. 7—Shunt-type contactor with blow-out coil

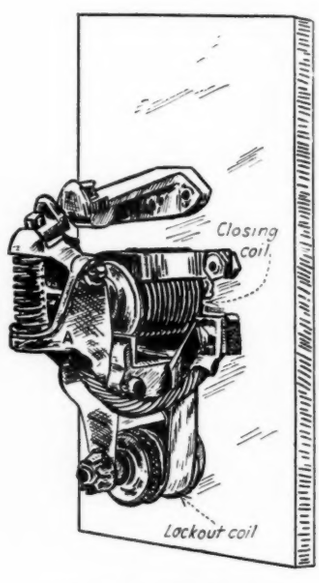


Fig. 8—Series-type contactor with lock-out coil

period. Since the resistor has capacity to carry the starting current for a short time only, if the short-circuiting switches fail to close, then the resistor may be burned out.

Reference to Fig. 6 shows that the current relays of the current-limit type of starter are set to close at points *B*, *G*, *M*, etc., all of which are slightly above the line *OE*, which represents the current taken by the motor at various speeds. The slope of this line may change on account of variations in the machine driven

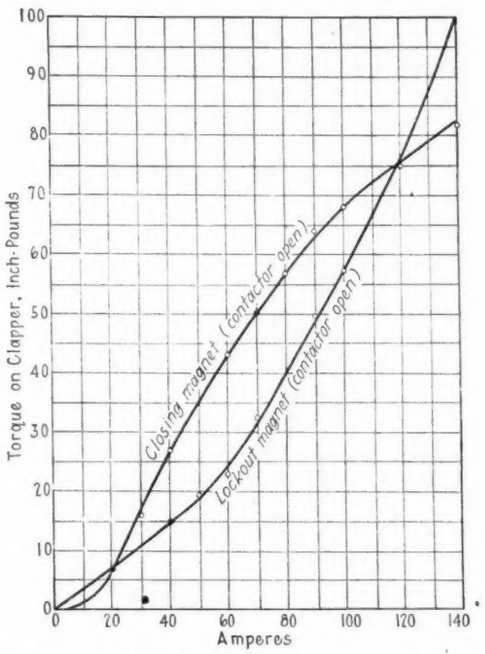


Fig. 9—Curves show relation between the pull of the closing and the lockout coils of the contactor Fig 8

by the motor. If the relays are set to close at a value below that represented by the line *OE*, they will not close at all, and consequently the resistor will not be short-circuited and will burn out.

Comparison of Time-Limit and Current-Limit Type Starters

Summing up the advantages and disadvantages of the time-limit and the current-limit type of starters, it may be said that if the time-limit starter fails to function, the protective devices will be tripped; whereas, if the current-limit starter fails to function, the resistor may burn out. The latter is, of course, a more serious condition, and for the ordinary case the time-limit starter is the more reliable. However, for inertia loads, such as motor generators with a flywheel, for example, the nature of the load is such that the slope of line *OE*, Fig. 6, can be predicted accurately and is not likely to change. Moreover, a factor of safety can be allowed; and since the current can be accurately controlled, the current-limit starter is to be recommended for such loads, especially since the starting time is, on account of the high inertia of the load, likely to be so long as to require an excessively large and expensive dashpot, if a time-limit starter is used.

A magnetic switch, used to short-circuit sections of a resistor, consists of a coil and an armature free to move under the influence of the flux created by the coil. This armature carries a copper finger, which, when the switch is closed, makes contact with a stationary post, thus completing the circuit. The coil may be of fine wire, designed to operate the switch at approximately generator voltage. This type of switch is usually known as a shunt contactor. Or the coil may be of heavy wire, designed to carry the motor current, in which case the switch is usually known as a series contactor.

Shunt-Type Contactors

A typical shunt contactor is shown in Fig. 7. The armature *A* is pulled up against the core *B* when the coil *C* is energized, thus causing the movable contact to engage the stationary contact and completing the circuit. For switches that carry considerable current these contacts are usually of copper. When the armature is in the closed position, the spring *S* is compressed and the contacts are held under considerable pressure. At the instant the contacts touch, the pressure is light, and at this instant the current is usually the highest. Consequently, there is likely to be sufficient heat developed at this instant to melt a small amount of copper and roughen the contacts. The contacts are, however, arranged to roll on each other during closing, so that the surface that finally carries the current is not the surface that makes the initial contact.

Series-Type Contactors

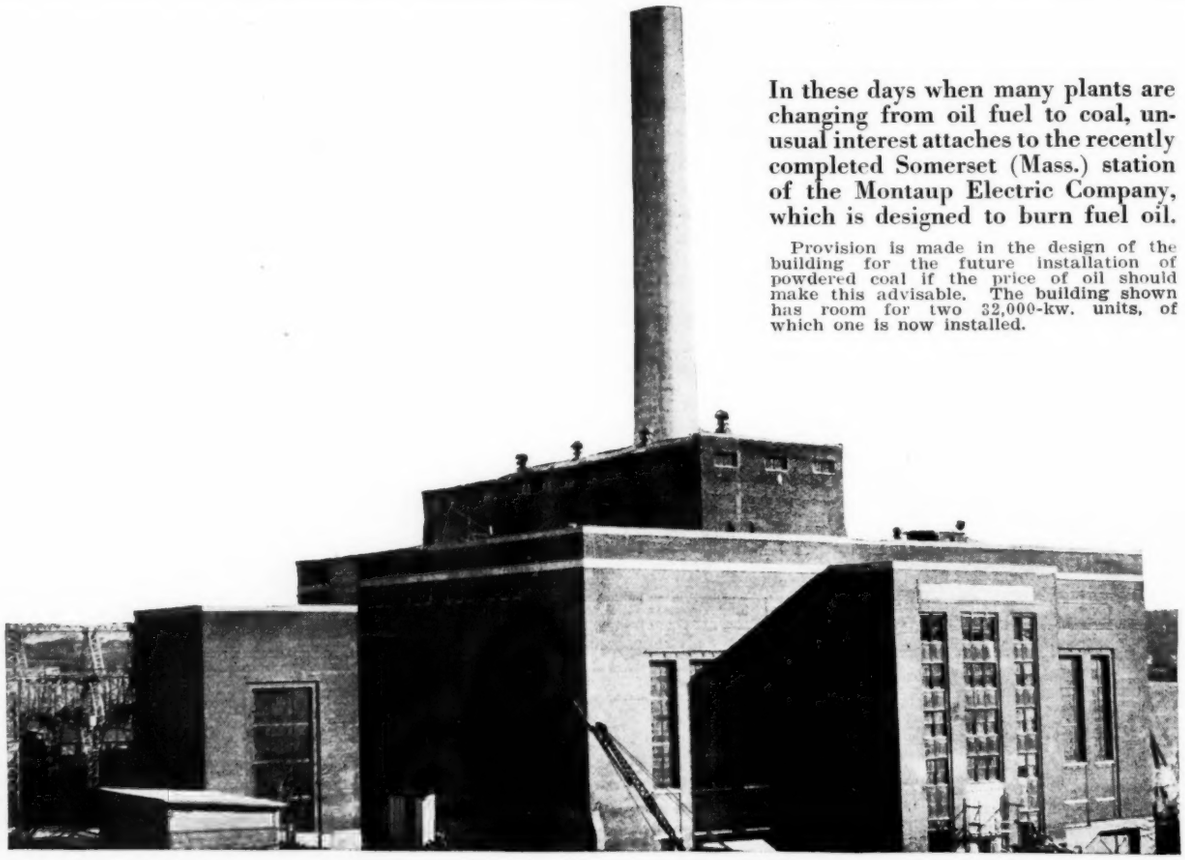
A typical series contactor is shown in Fig. 8. It will be noted that there are two coils of heavy wire both of which carry the motor current and pull on opposite ends of the armature *A*. The upper coil is the closing coil and the lower coil is the lockout coil, as indicated. The curves, Fig. 9, show that when the current is high, that is, above 120 amperes, the lockout coil has a greater pull than the closing coil. When the current has been reduced to a certain point, the closing coil pull overbalances the pull of the lockout coil, and the switch closes. The reason for the difference in the characteristics of the two coils is that the magnetic path through which the flux created by the lockout coil must pass has a large proportion of non-magnetic material (air); whereas, the magnetic circuit of the closing coil is almost wholly of iron. The magnetic circuit of the closing coil, therefore, is saturated at high-current values and its pull is limited; whereas, the flux in the lockout coil circuit increases in almost direct ratio to the current. Consequently, at a certain value of current the pull curves of the two coils cross, as indicated in the figure.

It will be noted that the shunt contactor, Fig. 7, is provided with a magnetic blowout, shown at the top of the contactor. This consists of a heavy coil *D*, which carries the motor current and is so wound that the flux it creates reacts with the flux due to the current in the arc which forms when the switch opens, and forces the arc away from the contacts. Blowouts are not usually necessary on series contactors, because series contactors are practically always used in connection with at least one shunt contactor, and the control circuits are so arranged that the motor circuit is broken by the shunt contactor.

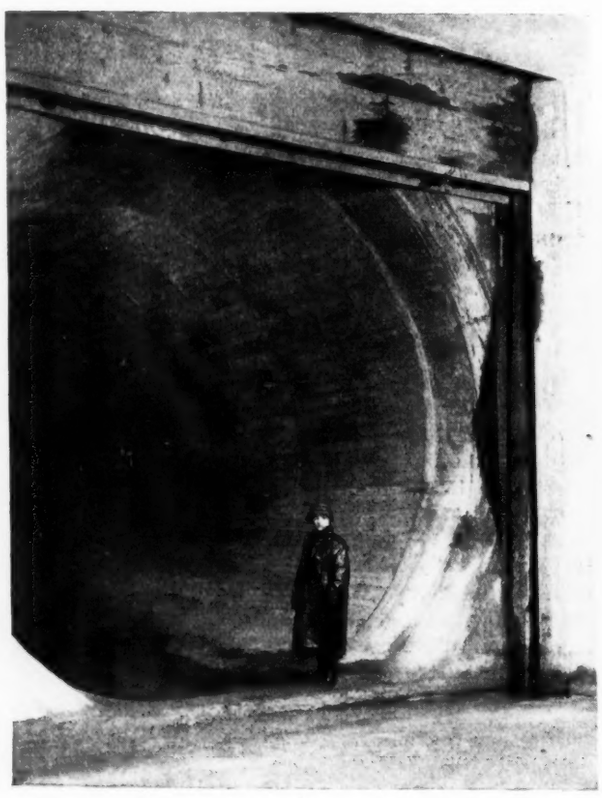
For testing purposes some plants keep a special portable steam meter mounted on a truck so that it may be moved about as desired.

In these days when many plants are changing from oil fuel to coal, unusual interest attaches to the recently completed Somerset (Mass.) station of the Montaup Electric Company, which is designed to burn fuel oil.

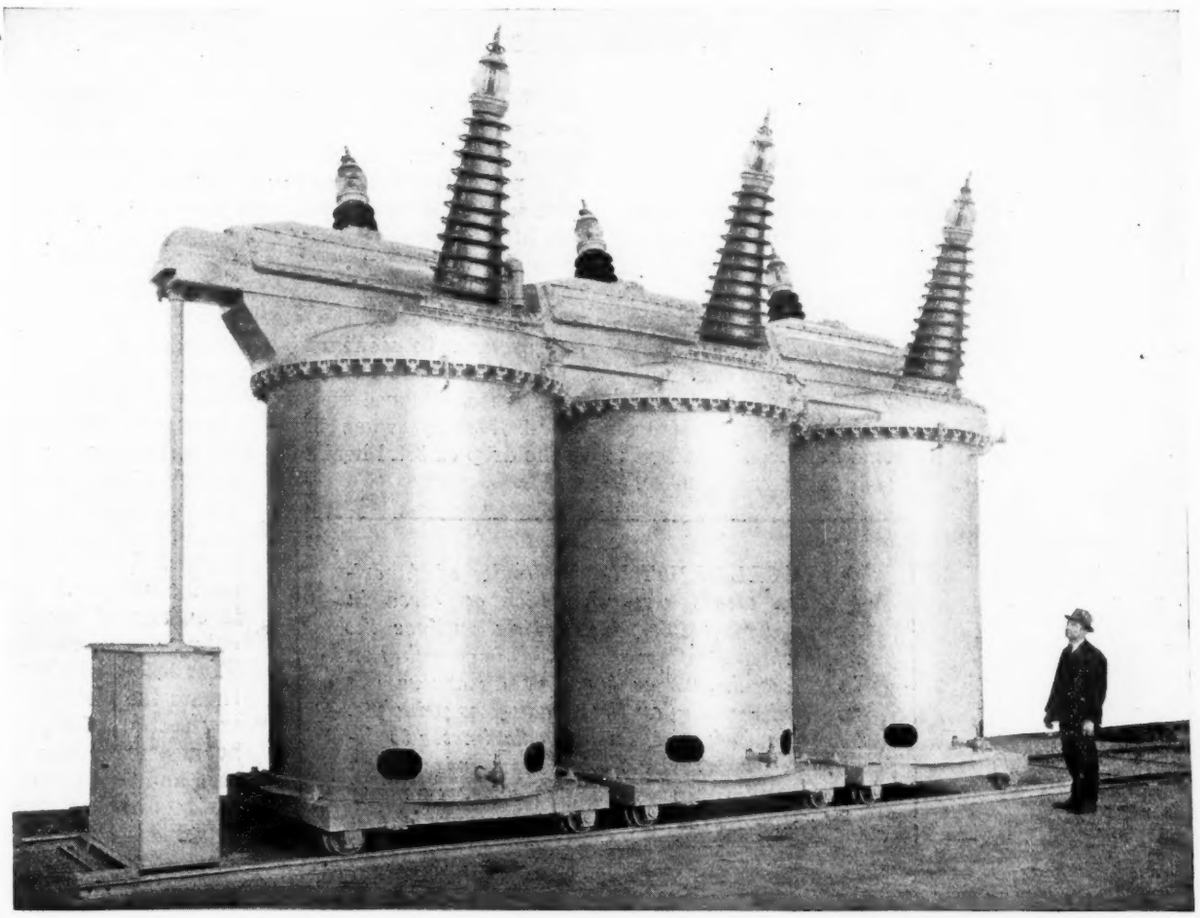
Provision is made in the design of the building for the future installation of powdered coal if the price of oil should make this advisable. The building shown has room for two 32,000-kw. units, of which one is now installed.



Below—Entrance to Gorge tunnel, part of Skagit River development of the City of Seattle, Wash. Other photographs of the Skagit River development appeared in the June 16 issue

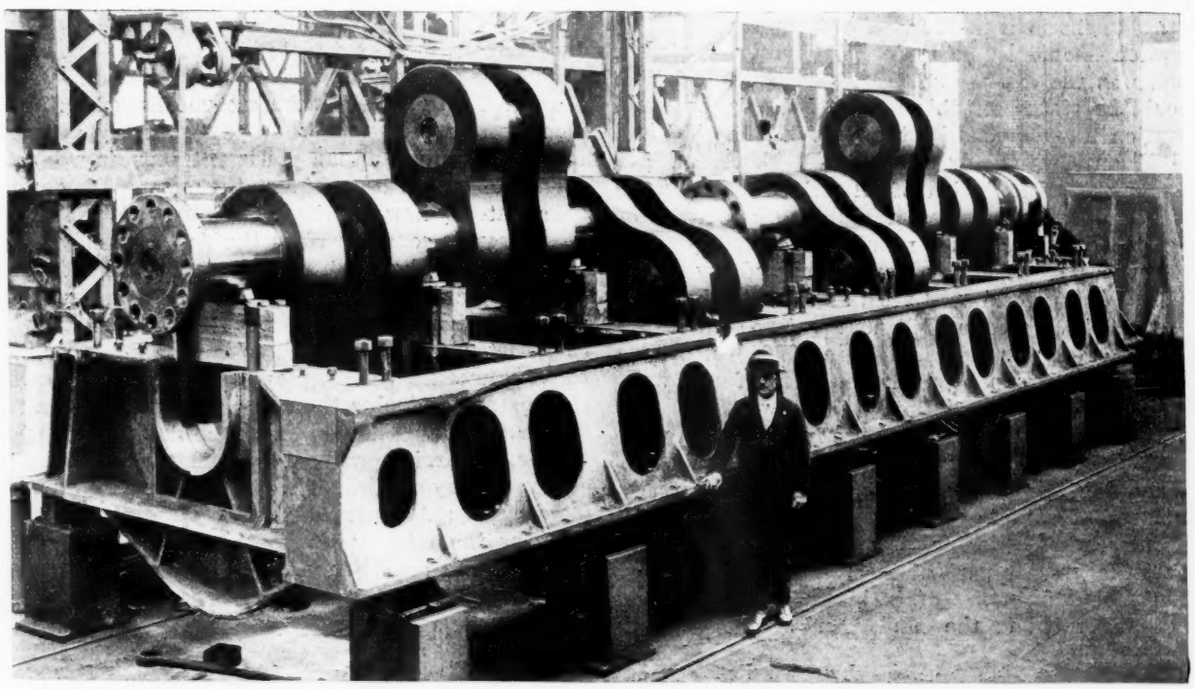


Below—Looking through one of the Moccasin riveted-pipe penstocks of the Hetch Hetchy development, where power is generated from the San Francisco water supply



Truck mounting, previously applied to small oil circuit breakers only, is used by the Tallahassee Power Company for this 154,000-volt, 400-ampere breaker, which weighs 51 tons

Photo by courtesy General Electric Co.



Crankshaft and bedplate for 3,000-hp. marine Diesel engine at Wm. Cramp's shipyard, Philadelphia

Steam Research

By I. V. ROBINSON*

A SERIES of four articles that appeared in *Power* during 1924 described the steam-research work now under way at certain centers in the United States under the auspices of the A.S.M.E., and it is desired to complete this series by describing investigations in the same direction being done in England by Professor Callendar, F.R.S., at the Imperial College of Science, South Kensington, London.

Preliminary details of the American research program were published in *Mechanical Engineering* during 1921, and from these it appeared that, with one exception, all sections of the work had been allocated to suitable institutions each with experienced observers. The one section for which no home had been found was the investigation of the specific heat of superheated steam at high pressures and temperatures. The writer is a great believer in co-operative action, and saw in this fact an opportunity for co-operation between the engineers and physicists of the two great English-speaking nations.

SUPPLEMENTING the stories of American steam research which appeared in Power *during 1924, this article outlines the work which Professor Callendar is carrying on in England. Three types of apparatus are used, all working on the steady-flow principle. These comprise a throttling calorimeter to determine total heat by comparison, an electric calorimeter for direct measurement of the specific heat at constant pressure and a condenser for direct measurement of total heat. All these are ingeniously designed not only to reduce heat losses to a minimum, but also to permit accurate determination of the heat-loss corrections.*

Accordingly, a suggestion was made to the British Electrical and Allied Industries Research Association that an offer should be made to those interested in the American research, that this unallocated investigation should be made in England by Professor Callendar at the expense of the Research Association. It should be stated, at this point, that this Research Association was founded by the British Electrical and Allied Manufacturers Association (B. E. A. M. A.) jointly with the Institution of Electrical Engineers to promote and carry out researches on all matters of interest to sections of their members.

This proposal was adopted and discussed, by correspondence, with George A. Orrok, and eventually about January, 1923, Professor Callendar got to work. He had been working on this subject in 1906, but the investigation was dropped because sufficient funds were not available for its completion.

On account of his great experience in connection with steam research, Callendar was asked to undertake the work, and the Association felt gratified by his ready willingness to assist.

The interest of this investigation arises from the fact that the greater part of the remarkable improvement in the performance of turbines in recent years must be attributed to the employment of the highest practicable degree of superheat in conjunction with necessary modifications of construction. Owing to the destructive and inefficient properties of wet steam at high pressures, little or no advantage can be obtained with saturated steam by merely increasing the pressure. The higher the pressure the more important it becomes to employ the highest attainable degree of initial superheat and to keep the steam dry throughout the high-pressure stages of the expansion, if any reasonable improvement in economy is to be realized.

The total heat is the most important property to investigate, because the work done in a turbine per pound of steam, when the flow is steady, is equivalent to the drop of total heat of the steam between the valve chest and the condenser, after applying small corrections for any external loss of heat from the casing and for the kinetic energy of the steam entering the condenser. Thus it is possible to estimate the work done in any section of a turbine by measuring the pressure and temperature at the required points and deducing the heat drop, provided the total heat is known in terms of the pressure and temperature.

A precisely similar relation applies to any apparatus through which a fluid is flowing steadily from one measured state to another. Such methods are widely utilized in steady-flow calorimetry and afford the most direct and accurate means of measuring changes of total heat. They possess many advantages over the more familiar static methods in which the change of temperature of a stationary mass is observed.

In a steady-flow calorimeter the temperature of every part remains constant when the flow is steady, so that the "water-equivalent" is not required, thus avoiding a troublesome and uncertain correction in the use of the apparatus at high temperatures. The size of the calorimeter may be reduced to the minimum necessary to accommodate the flow and the thermometers, etc., thus greatly reducing the external heat loss for a given heat exchange. The motion of the fluid itself supplies sufficient stirring without special mechanical appliances and may also be utilized to maintain the surrounding jackets automatically at nearly the same temperatures as the vital parts of the calorimeter that they inclose. The conditions being constant, the temperatures and pressures are readily observed to the required limit of accuracy without any risk of errors due to time lag. The apparatus required is comparatively simple and easy to make in a variety of forms and dimensions, with a view to the detection and elimination of

*The author, an English engineer, is a Whitworth Scholar, member of the A.S.M.E. and of the Institution of Mechanical Engineers (Great Britain).

systematic errors by varying the conditions of operation as widely as possible.

Thus Callendar's methods differ essentially from those adopted by most other investigators, as he uses a steady flow process.[1] In this method, instead of dealing with a stationary mass of steam and subjecting it to certain changes, the steam is passing steadily through the apparatus at a known rate.

The basis of Callendar's method of measuring the specific heat at high pressures and temperatures is really the classical porous-plug experiment. Steam from known initial conditions is expanded, without doing work, to a pressure just above atmospheric, when its pressure and temperature are again measured. This enables the total heat under the initial conditions to be measured in terms of the total heat at atmospheric pressure.

Another variation of the apparatus enables the specific heat at atmospheric pressure to be determined at any temperature, and these two sets of experiments enable the specific heat at high pressures and temperatures to be determined.

A further simple variation allows the latent heat of steam to be measured at one particular pressure and temperature referred to the state of water at the freezing point.

From these three sets of observations the absolute value of the total heat at any temperature and pressure is readily deduced.

The three types of apparatus are: (1) A throttling calorimeter; (2) an electric calorimeter; (3) a condenser, used in conjunction with the throttling calorimeter.

In the throttling calorimeter, a simple type of which is sketched in Fig. 1, a steady flow of high-pressure steam at any desired superheat is supplied to the central pocket, where its temperature and pressure are measured. The main current then divides right and left

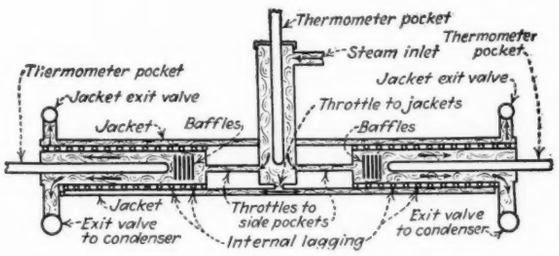


Fig. 1—By operating this double throttling calorimeter with different flows (but equal pressure drops) to the two sides, the heat-loss correction may be accurately determined

through the two throttle tubes to the horizontal thermometer pockets, where its temperature is again measured before passing to the condensers, through valves, by means of which the pressures in the two pockets are adjusted to equality at a point slightly in excess of atmospheric. The side jackets surrounding the pockets are supplied with steam through a throttle at the bottom of the central pocket. The steam leaving the jacket passes to a separate condenser at atmospheric pressure. The central pocket is also jacketed with its own steam, and the whole apparatus is lagged externally with about an inch thickness of asbestos, which serves to keep the jackets at nearly the same temperature as the throttled steam in the side pockets. But these details of construction could not be shown in the diagram without obscuring the main principle.

The theory of the experiment is extremely simple. Since the flow is steady and no external work is done by the throttles, the drop of total heat between the central pocket and either side pocket reduces to that due to external heat loss and gain of kinetic energy, if any, of the steam. The apparatus is designed so that the gain or loss of kinetic energy for the maximum flow of 3 lb. per min. can never exceed a twentieth of a B.t.u. per pound. Since the two side jackets are at the same temperature, the rate of heat loss from the

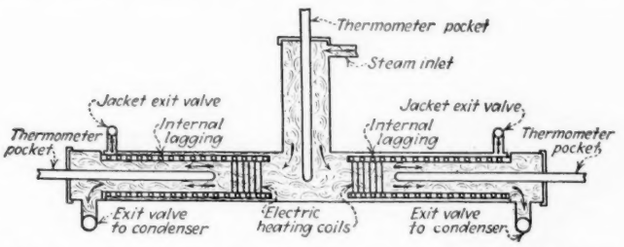


Fig. 2—Electric calorimeter for measuring specific heat at constant pressure

side pockets is the same and is usually between 1 and 2 B.t.u. per min. at 800 deg. F. If the two throttle tubes are chosen to give flows in the ratio of 2 to 1, the drop of temperature due to heat loss will be twice as great for the thermometer in the right pocket as it is for that in the left. Thus the temperature in the left-hand thermometer corresponding to absence of heat loss, or to equality of total heat between the initial steam at a high pressure and the throttled steam at atmospheric pressure, is obtained by simply adding the difference of temperature between the two thermometers to the observed temperature of the left-hand thermometer. The differences of temperature between the center and left pockets and between left and right are directly measured with differential platinum thermometers, in addition to the actual temperature of the left pocket. Thus it is easy to deduce the actual value of the total heat at any high temperature and pressure, when the value of the total heat at atmospheric pressure is known.

The differential electric calorimeter shown in Fig. 2 is designed for measuring the specific heat at atmospheric pressure at any temperature and is similar to the differential throttling calorimeter just described, except that the central pocket is larger and the throttles are replaced by electric heating coils. These serve to add a measured quantity of heat to the steam without appreciable throttling on its way from the center to the side pockets, where the resulting rise of temperature is observed. The side pockets in this case are jacketed with steam at the initial temperature and pressure and are separated from the jackets by a layer of fine asbestos lagging. The heat loss from the pockets is approximately proportional to the rise of temperature due to the electric heat supply and is determined in the manner explained by Professor Callendar in many papers.

It will be seen that in the electric calorimeter the pressure is practically uniform throughout the apparatus, so that the quantity measured is the specific

[1] A steady flow (throttling) process is being used by Professor Davis and Doctor Kleinschmidt at Harvard.

heat at constant pressure. The flows on the two sides are set to a suitable ratio by means of the exit valves, and the wattage on the heating coils is adjusted to make the temperatures indicated by the side thermometers the same, so that the rate of heat loss may be the same on either side. The actual temperature t_2 is measured in the left pocket, in addition to the difference $t_3 - t_1$ for the rise of temperature due to the electric heating. If $t_2 = t_3$, the right-hand temperature, then the true value of the specific heat, corrected for heat-loss is obtained by dividing the difference of the watts on the two sides (reduced to B.t.u. per minute) by the difference of the flows in pounds per minute and by the rise of temperature in degrees Fahrenheit.

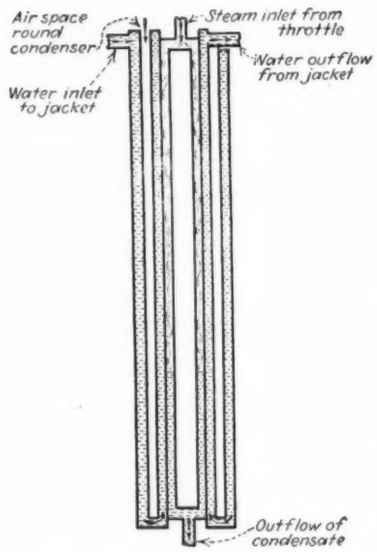


Fig. 3—Condenser for direct measurement of total heat

The foregoing is the most direct method of obtaining the corrected value of the specific heat with the differential apparatus, but it requires the simultaneous observation of so many different quantities with the utmost accuracy as to be somewhat arduous when two observers only are available. For this reason other methods of operation have also been employed in order to obtain independent verification by varying the conditions of measurement. The following method has frequently been used with the same apparatus and affords a good illustration:

Instead of taking the two flows required for the elimination of the heat loss simultaneously, they are taken consecutively, as in the original experiments for the determination of the specific heat of water by the same method. In this case the steam flow is adjusted to be *the same* on both sides of the apparatus, but one heating coil only is employed, and the flow on that side accurately measured, together with the difference of temperature between the two side pockets. The flow through the pockets is then reduced to one-half without altering the pressure or the flow through the jackets, and the watts are readjusted to give the same rise of temperature and rate of heat loss as in the previous case.

A number of large and small flows are taken alternately in this manner without altering the initial conditions, and the results are combined in the manner previously indicated so as to give the value of the specific heat corrected for heat loss. This method takes longer to carry out, but it has the advantage that the number of quantities to be measured simultaneously is reduced by one-half, and that it automatically eliminates the effect of any small variations of temperature in the superheaters, which are the chief source of trouble at high temperatures.

By combining the results of these two methods, the *variation* of the total heat of superheated steam is completely determined for all pressures and temperatures in the experimental range. The values of the total heat reckoned from the freezing point of water are easily deduced by assuming any one value of the latent heat of vaporization. But since most of the measurements of latent heat have been made by static methods at the saturation point, where they are liable to be affected by uncertain errors due to possible wetness of the steam, it has been thought desirable to make some independent determinations of the total heat, including the latent heat of condensation, by a steady-flow method in which the heat given up in the condensation of *superheated* steam is directly measured. This is most readily effected with the requisite degree of accuracy by condensing a steady current of superheated steam, initially at a measured temperature and pressure, by means of a steady current of water, and measuring the rise of temperature of the circulating water and the final temperature of the condensate.

A suitable form of condenser for this purpose, designed to minimize the external heat loss, is shown diagrammatically in Fig. 3. The initial temperature and pressure of the superheated steam are measured in the central pocket of Fig. 1. The steam is then passed through a throttle, which serves to regulate the flow without altering the total heat. The throttle is directly connected at the top of the central pocket (Fig. 1) to the condenser shown in Fig. 3, which replaces the thermometer pocket of Fig. 1. The steam is completely condensed, and the condensate flows out through a thermometer pocket at the other end of the condenser, where its temperature is measured before passing through a cooler to the weighing tank. The condensing water at atmospheric temperature flows into the condenser and circulates around the external jacket, which serves to prevent any escape of heat from the condenser. The water circulates back around the steam tube. The rise of temperature of the condensing water is observed with a pair of differential platinum thermometers inserted in suitable pockets close to the inflow and outflow.

Under these conditions the loss of total heat of the steam in passing through the condenser is equal to the gain of total heat of the water multiplied by the ratio of the weight of the water to that of the steam. To obtain the total heat reckoned from the freezing point, it is necessary to add the total heat of the condensate. The external heat loss from the condenser is less than one part in a thousand of the heat transferred, but the loss from the superheated steam before reaching the condenser raises the total loss to nearly one-third of one per cent. The heat-loss is estimated in the usual way by using different flows under the same conditions of temperature.

The methods employed by Professor Callendar can hardly fail to be of interest as affording an independent verification of the accuracy of the results obtained by the American investigators.

Just as it has been pointed out in the earlier articles that the three American researches are mutually self-checking, so Callendar's work affords yet another check. If the four sets do not agree, within the limits of error of observation, there must be further careful consideration before any results are published.

The writer desires to acknowledge the great assistance received from Professor Callendar in the descriptions of the apparatus and the preparation of the illustrations.

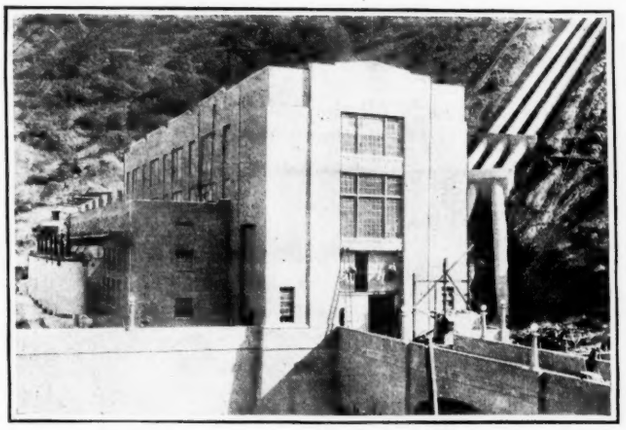
Venturi Meters Used in Hydro-Electric Plant Operation

By J. M. GAYLORD
Hydro-Engineer, Operating Department
Southern California Edison Company

ELEVEN meters installed in four plants with heads ranging from 800 to 2,130 ft. to indicate, record and integrate the flow of water to the wheels. The use of these meters has resulted in a considerable increase in the kilowatt output of the stations.

IN THE operation of a modern hydro-electric plant, accurate information as to the flow of water is greatly to be desired. Such information is of value to the load dispatcher who must meet the demands of the load, to the operator who controls the generating units, and to those responsible for the maintenance of operating efficiency in the plants. In stream-flow plants the record of flow is the history of the stream and, as such, is of service in forecasting future output. Stored water used by a plant has the value of its fuel equivalent and should be measured and used with the same regard to economy as in the case of fuel. The maintenance of efficiency of the prime movers is important especially in large units, where a slight drop in efficiency means a considerable sum of money added to operating expense through greater fuel consumption.

Wear of the needles and nozzles of impulse wheels and wear of seal rings increasing runner clearances in hydraulic turbines are important causes of loss of efficiency. The extent of such deterioration cannot be determined except by test and accurate measurement of water, which in the absence of a meter is usually difficult and expensive.



Big Creek No. 3, rated at 105,000 horsepower

Tests made at the Big Creek Nos. 1 and 2 plants of the Southern California Edison Co. in 1922 indicated that worn nozzles on one unit were causing a loss of several hundred dollars a month. These tests led to the installation of a Venturi meter in the penstock leading to each unit and the incorporation of Venturi meters in the design of new developments. The following installations have been made by this company:

Venturi-Tube Installations

In Big Creek plant No. 1, which operates under a 2,130-ft. head, three 125-sec.-ft. meters have been installed. Big Creek No. 2, the head on which is 1,850 ft., has three 135-sec.-ft. meters. The penstock for each of the plants is 36 in. in diameter and the throat of the Venturi tube 29½ in. At Big Creek No. 3 the head is 800 ft. and three 500-sec.-ft. meters have been installed in 78-in. penstocks; the throat of the Venturi tube is 52½ in. in diameter. All of the foregoing were supplied by the Simplex Valve & Meter Co. Kern River plant No. 3 has two 500-sec.-ft. meters in 44-in. penstocks operating under a head of 800 ft., which were furnished by the Builders Iron Foundry. The installations are so near alike that a description of one will serve for all.

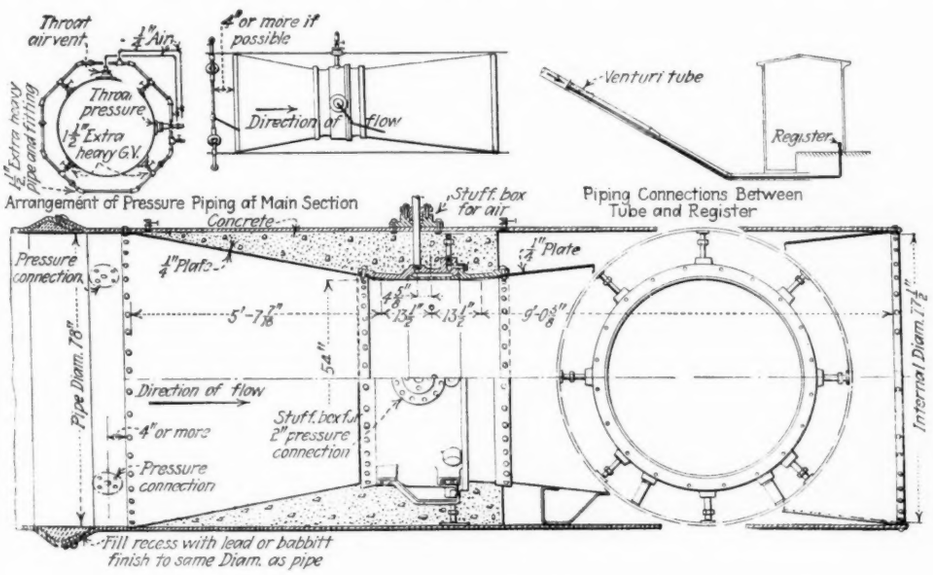


Fig. 1 — Section through Venturi tube and general arrangement of piping between tube in penstock and meters in power house

The Venturi tube consists of a finished casting to which are riveted plate-steel taper sections. The casting is centered in the penstock by means of steel skids and centering bolts and the outer ends of the tapered sections are riveted to the penstock. Concrete is used to fill the space between the tube and the penstock. The throat ring has eight ⅜-in. holes leading to an annular chamber, from which the throat pressure is obtained for operating the meter.

The Venturi tube, Fig. 1, consists of a carefully finished casting to which are riveted plate-steel taper sections. The casting is centered in the penstock by means of steel skids and centering bolts, and the outer ends of the taper sections are riveted to the penstock. Concrete is used to fill the space between the penstock and the tube. The throat ring is a finished bronze

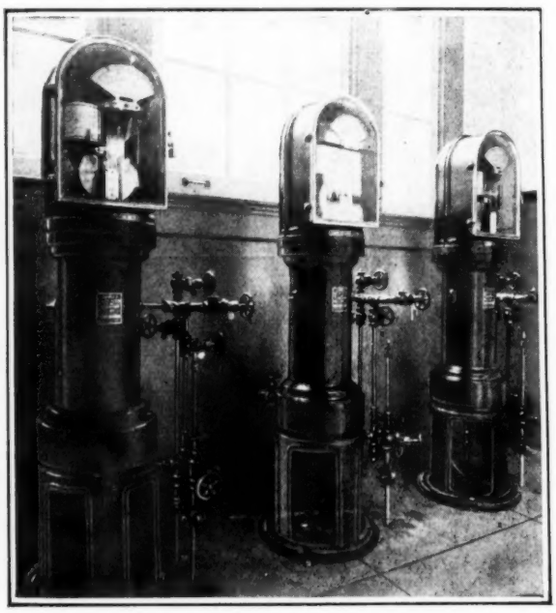


Fig. 2—Venturi meters installed in Big Creek No. 1 plant

casting with eight ¾-in. holes leading into an annular chamber from which the throat pressure is obtained for operating the meter. Penstock pressure is taken at four points around the circumference by means of accurately drilled bronze bushings ground flush with the inside of the pipe and connected by means of an equalizing ring of piping outside the penstock.

The tube is located as close to the power plant as it is possible to obtain a sufficiently long section of straight penstock. Connections are made with the recorder by pipes of suitable size to insure proper transmission of slight pressure changes and laid in such a manner that air pockets are avoided. In some locations the pipes must be protected against freezing.

Meters Are of Standard Make

The recording instruments, Figs. 2 and 3, are of standard make, combining in one instrument an indicating dial reading in sec.-ft., a graphic chart recording sec.-ft. and a register integrating the cubic feet of water passing through the meter. Suitable connections are provided for connecting a U-tube for calibrating the instrument. The recorders are located in the plants adjacent to the generating units.

The operation of the meters has been satisfactory. A slight amount of trouble has been experienced with air becoming entrapped in the recording instrument and piping, and at low capacities when the meter is operating on a small differential pressure the indications are somewhat sluggish. Neither of these difficulties, however, has materially interfered with the usefulness of the meter, and its indications are considered as sufficiently reliable and accurate for all purposes of operation. In fact, under comparative tests these meters have given more consistent and satisfactory results than other methods of water measurements. As one of the division superintendents recently expressed it:

> The value of the Venturi meter in the operation of the station depends altogether upon how much attention is paid to its records. If these records are filed and forgotten, as are the majority of records in the stations, no benefit is derived. If, however, the Venturi and machine output records are carefully analyzed each day, a very material increase in the output of power per unit of water through the turbine is usually possible.
>
> We have found that where this information is available for the operating force, they take considerable interest in trying to increase the output of their machines or plants per unit of water used. This in one particular instance amounted to about a 30,000-kw.-hr. increase in the output of the plant over a 24-hour period, due to more efficient loading and distribution of load between units.

Meters Stimulate Interest of Operators in Their Work

Most operators realize that maintaining a high-water elevation in the forebay tends to increase the plant output through increasing the head, but this fact is likely to lose its force unless definite information as to the water used is available to compare with the plant output.

The information furnished by the meters makes possible a continuous check on the output per unit of water and furnishes a means of detecting losses due to poor condition of equipment which might otherwise remain undetected for long periods. In one instance serious wear of the seal rings of a reaction turbine was detected in this way. A reading of kilowatt-hour output and water used over a period of several hours at a steady load with the unit in good condition gives a standard of comparison. Periodic tests of this nature are made in the various plants, and if unsatisfactory

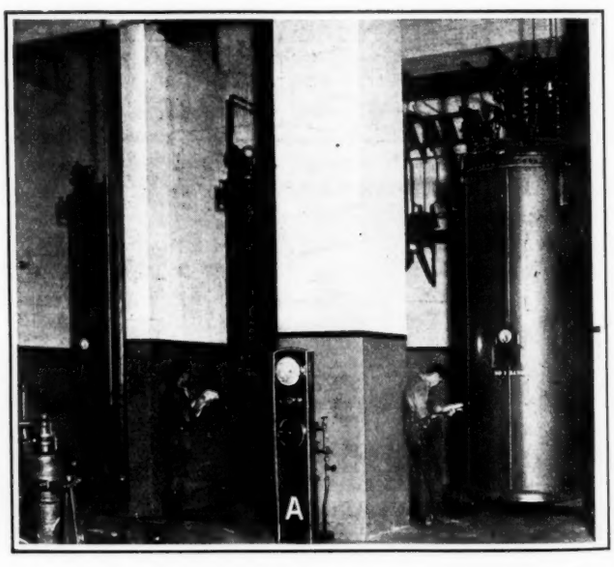


Fig. 3—One of the Venturi meters installed in Kern River No. 3 plant is shown at A

results are obtained, the causes are investigated. Water meters are considered an important if not essential part of the equipment of the modern hydro-electric plant.

Small-sized turbines for auxiliary drive may be built at much greater efficiency if a demand occurs. Reduction gears will be essential.

Effect of Altitude on Power-Equipment Performance*

WHERE the atmosphere has an influence upon the performance of machinery or apparatus of mechanical or electrical nature, it is due to the variation of its density. Atmosphere or air forms a concentric layer around the earth, and its radial thickness is variously estimated between 30 and 100 miles.

Consisting of a mixture of various gases, air is subjected to the effect of gravity, and its specific weight decreases as the distance from the earth's surface increases. At higher altitudes air becomes thinner, offers less resistance when moved, and as the chemical components remain about in the same ratio, a cubical unit of air will contain a smaller amount of these various chemical constituents. The human respiratory system is gaged and adjusted so that with each inhalation a certain amount of oxygen, one of the gaseous components of air, is drawn into the lungs. If considerably less than this amount is supplied to the lungs, nausea is caused, for which reason balloonists and flyers, who expect to reach great heights, carry auxiliary oxygen with them in order to supplement the gradually diminishing natural supply.

The rating of machines is always meant for sea level or at low altitudes. For higher altitudes this rating will be changed, in some cases quite considerably. Just how much the rating of various machines has to be changed for rising altitudes is not common property, for which reason some data are given in this article on the subject.

The change in density of the air brings about the following changes of the property of air: (1) Change of weight per cubical unit; (2) change of heat conductivity; (3) change of oxygen content per cubical unit; (4) change of dielectric strength.

Depending upon the machine or the apparatus under consideration, one or more of these four changes will be responsible for a changed rating.

The relation between altitude and barometric pressure is shown as a curve in the figure.

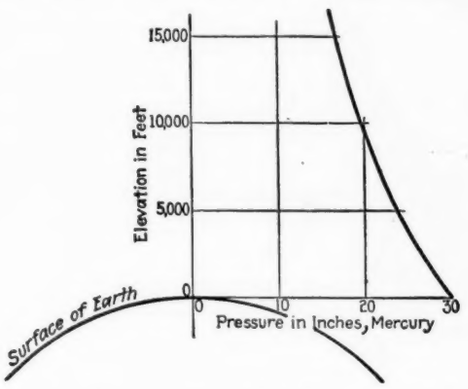
Internal Combustion Engines

The weight of the air volume, taken in at each stroke of an internal-combustion engine, varies with the air pressure and affects therefore the indicated output of the engine considerably. As the mechanical losses remain the same, the effective output drops faster than directly proportional with the air pressure. Actual measurements showed a decrease of 1 per cent for every 330 ft. elevation and the fuel consumption increases about $\frac{3}{4}$ per cent.

Steam engines operating condensing are practically unaffected by altitude. For those operating non-condensing, a lower back pressure is found when installed at higher altitudes which results in a decrease in steam consumption. For example, at a total steam temperature of 482 deg. F., the steam consumption of an engine will be decreased about as given in the tabulation:

Pressure, Lb. per Sq.In.	Altitude, Ft. 4,000	8,000
145	4 per cent	8 per cent
290	3 per cent	6 per cent

As the wind pressure decreases with decreasing air density, the output of a windmill will drop proportionally for higher altitudes, at the same wind velocity and temperature. For example, if a mill gives 20 hp. for a wind velocity of 20 ft. per sec. at sea-level, only 14 hp. can be expected of the mill under similar condition at 10,000 ft. elevation. Or if 20 hp. is needed at 10,000 ft. altitude, a wheel for 29 hp. at sea level would have to be installed.



How air pressure varies above sea level

Only the suction height of pumps is affected by altitude. At sea level and 32 deg. C., a 34-ft. column of water can theoretically be raised in the suction pipe of a pump. Owing to inner friction losses only about 65 per cent of this value, or 22 ft., can actually be realized. At 5,000 ft. the raised column will drop to only $15\frac{1}{2}$ ft. and $10\frac{1}{2}$ ft. at 10,000 ft. level.

Electric Generators, Motors and Transformers

A decrease of air pressure will cause a poorer disposal of heat, generated in these machines. In addition the weight of air, propelled by the armature, assisting in the cooling action, becomes less per unit of time. These two factors may cause an overheating of a machine if it is operated at its rated (sea level) output at high altitude. In rather close approximation the A.I.E.E. Rules provide a decrease of 1 per cent for every 330 ft. of elevation.

The dissipation of heat from self-cooled or forced-air cooled transformers decreases with rising altitude. Sufficient leeway is usually provided in the available tank or radiator surface to permit rated output up to 3,300 ft. altitude. Above this limit transformers should be operated at $\frac{1}{2}$ per cent less output for every 330 ft. additional altitude to insure the same temperature rise. For example, a 50-kva. transformer at 10,000 ft. can be loaded to $50 - \frac{10{,}000 - 3\,300}{330} \times 0.005 \times 50 = 45$ kva.

*For more detailed information on this subject see A. E. G. Mitteilungen, issues Nos. 6 and 7, 1924.

10 per cent less. If the undiminished output is required, either the next larger size transformer has to be chosen or core and coils must be placed in a larger tank.

High-Voltage Apparatus

The dielectric strength of air drops with decreasing air pressure and increasing temperature. As these same two factors determine the relative density of air, this becomes the governing influence of the puncture voltage of air. To obtain the same factor of electrical safety for high-altitude erection of high-voltage apparatus such as lightning arresters, oil switches and transformers, etc., a certain correction will have to be made, either to reduce the operating voltage or to equip the apparatus with adequately larger insulators. With an accuracy usually sufficient for practical purposes, this correction factor may be determined by the formula,

$$F = 1 - \frac{A}{32{,}600}$$

where A is the altitude in feet in excess of 3,300 ft. Up to this height the voltage reaches the average safety factor. For example, an apparatus rated for 110,000 volts, when installed at an altitude of 10,000 ft. should be operated with only 87,000 volts, because $F = 1 - \frac{(10{,}000 - 3{,}300)}{32{,}600} = 0.79$ or 21 per cent less. Or the apparatus would have to be equipped with insulators suitable for $\frac{110{,}000}{0.79} = 140{,}000$ volts at sea level. This correction for insulators applies, as has been said before, also to transformers, so that on these machines one correction for thermal reasons and a second correction for electric reasons have to be made.

High-Voltage Transmission Lines

A high-voltage transmission line, calculated for and satisfactorily operated at sea level, will suffer a number of additional losses at high altitudes. The thinner air will cause more corona losses, the insulators will have a lower flash-over, and the wires may be found too close together or to the towers. The exact evaluation of these various corrections is rather complex. For an estimate it may be assumed that a line laid out for 110,000 volts at sea level would have to be dimensioned for 185,000 volts when at an altitude of 13,000 ft. Intermediate values may be assumed as practically proportional.

Employing solid insulating materials, cables are practically not affected by variations in altitudes.

Instructions for Firemen

The following instructions for firemen in stationary plants are condensed from the report of the seventeenth annual meeting of the International Railway Fuel Association:

Before starting the fire, the firemen should ascertain the water level by gage glass and gage cocks. The condition of the safety valve should be noted. If the fire has been banked over night, open the dampers and remove the ashes and clinkers from the grate. The fire at the start should be slow, to cause a gradual and uniform heating of the water and various parts of the boiler.

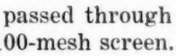
There are three general methods of firing—spreading, alternate or side-firing and coking. Spreading is accomplished by placing small quantities of coal uniformly over the entire surface of the grate at short intervals. With this method, the coal is thrown just where it is wanted and left undisturbed. If the coal is of the right sort, good results are obtained from this method. The door should be kept open as little as possible when firing to avoid unnecessary admission of cold air. For a short time, while the coal is giving off gas, the draft plate of the furnace door should be opened, to admit sufficient air above the coal to burn the gas. The spreading method is especially effective for high rates of combustion.

When the alternate or side-firing method is used, coal is spread so as to cover one side of the fire completely at one firing, leaving the other side bright. At the next firing the bright side is covered. The gases given off by the fresh coal are assisted in burning by the hot gases coming from the incandescent coal. This method is superior to spreading.

With semi-bituminous coal, which is largely volatile and burns with considerable smoke, the coking method is used. The coal is piled on the grate just inside the door and allowed to coke from 15 to 30 minutes. During this time the hydrocarbons are driven off and burned while passing over the more intense fuel bed behind. In order to accomplish this fully, air must be admitted in small quantities above the grate through the draft plates of the furnace doors. The coke is next pushed backward over the fire and a new supply placed on the front of the grate. It is important that the air admitted over the fire be enough, but not excessive. Excess air lowers the furnace temperature and reduces plant economy.

A fire fifteen inches thick is considered about right for a good coking coal, while a fire five inches thick is about right for a free-burning bituminous coal. It may be desirable to change the grate area to carry better the desired load with proper thickness of fuel bed.

After finding from experiment the best thickness of fuel bed, keep it at that thickness. Always keep the fuel bed of uniform thickness. Never let the fire burn holes in it. Do not let the rear of the grate become bare. If a larger amount of steam is required, fire smaller quantities at more frequent intervals. The firing of fresh coal chills the furnace and temporarily retards combustion. Keep the fire free from ashes and clinkers, but do not clean it oftener than is necessary.



In the past it was thought that to insure efficient combustion with powdered coal it must be pulverized so that 85 per cent passed through a 200-mesh and 90 per cent through a 100-mesh screen. The tests at Lakeside and subsequent experiments with coarsely pulverized coal indicate that, with this type of furnace and burners, it makes little difference what percentage of the coal passes through 100- to 200-mesh screens if nearly all of it passes through 50-mesh screens. As long as all the coal is so fine that the individual particles will stay in suspension in the gases, the coal can be burned efficiently; but as soon as the pulverized coal contains heavy particles which will not stay in suspension in the furnace gases, these particles fall to the bottom of the furnace, where they smolder and are largely removed unconsumed with the refuse. All particles of coal that pass through a 50-mesh screen seem to float in the surface gases, and most particles that will not pass through this screen seem to fall to the bottom; this distinction, however, obviously depends on the depth of the furnace and the velocity of the furnace gases.—*Bureau of Mines Bulletin No. 237.*

Scientific Engine Selection

IT IS a truism that one engine is about as "efficient" as another in using energy to produce power, as long as all the exhaust is needed for heating or process. Yet the low-steam-rate engine will produce *more* power from a given flow of steam. Only in the exceptional plant is the process and heating load so high that the needed power can be generated in summer without wasting some exhaust. Thus, in the majority of industrial plants the installation of a more efficient engine effects a marked saving during the summer and increases the number of months during which power is entirely a byproduct.

The rational selection of a prime mover should be based on the study of curves showing the hourly plant requirements for heat and power for a typical day in each month of a typical year. When considering the installation of a prime mover of given capacity and with a given steam-consumption curve, it is no great task to work out hour by hour for one day of each month the total consumption of steam for power and heat. From this can be deduced the total yearly operating cost, which, added to the yearly fixed charges on the assumed installation, gives the total yearly cost.

A study of this sort carried through for various available prime movers gives a rational basis for selection. The large sums of money involved make the expenditure of a day or two in this sort of figuring the finest kind of investment. A net saving of a mere one hundred dollars per year by preliminary study is equivalent to one thousand dollars in a lump sum when capitalized at ten per cent. If the study need not be made for a year or two, now is the time to install recording instruments to build up a record of facts on which to base the future decision.

Our Southern States

HORACE GREELEY is said to have given the following advice to the young men of a few generations ago: "Young man, go West." A young mechanical engineer who feels a desire to migrate at the present time could probably receive no better advice than to go to one of the states of our old South. No section of our country promises such rapid development in the near future as these Southern States.

For many years after the Civil War these states remained impoverished and misgoverned, and no progress was made. The population received little or no additions from immigration and has therefore the greatest ratio of American-born citizens, largely of Anglo-Saxon strain, of any section of our country. These people, as recent developments have shown, have inherited much of the mechanical and industrial ability of their forebears and rapidly adjust themselves to modern industrial conditions. Adequate labor supply, coupled with an equitable climate over the Piedmont plateau and the great natural resources, is attracting many large manufacturing concerns to the South. The migration of the cotton industry has been under way for several years. In general, cotton goods can be produced more cheaply in the South than in New England where labor troubles are more frequent. It is probable that the Southern mills will run steadily on base-load cotton demands while the New England mills will be operated more or less intermittently to meet the peak demands of that industry.

The iron and steel industries of the South, particularly in Alabama, are developing rapidly and will continue to expand as local iron-using industries spring into being. Cotton mills require repair shops, and these also will create demands for iron products. Coal is plentiful and will later attract other industries.

Agriculture is undergoing great development, and many improved methods will be introduced as a result of the migration of the plantation negro to the northern cities. This will call for increased fertilizers and for their manufacture in the South.

The hydro-electric developments of the South for many years have been most impressive and have attracted wide attention. A number of power sites still remain to be developed, including small ones where automatic generating stations can be installed. Water shortages have made the construction of stand-by steam stations necessary. Cheap and easily available coal will encourage the construction of many more new steam central stations. Mill processes requiring steam will cause power plants to be built at the factories.

The towns and cities must have ice, gas, electricity, good water and adequate transportation. The country needs good and permanent roads. Seaports must be developed. Sugar factories, oil refineries, etc., will follow. Texas and Louisiana have salt and sulphur. Other states have large mineral deposits.

The South is on the threshold of rapid economic and industrial developments, and the stage seems to be set for these to take place with increased rapidity in the near future. With this picture in mind there would appear to be ample opportunity for the young migrating engineer in the Old South.

Hydrogen Used in Generator Cooling Systems

WITH high-speed turbo-generators, the small dimensions for a given capacity made forced ventilation necessary in order to dissipate the heat developed. In fact, these machines require forced ventilation at no load to keep them from reaching a temperature destructive to the insulation. Although air has been heretofore the cooling medium, it has been felt that a more satisfactory cooling fluid or gas was desirable. The windage losses with air as a cooling

medium are not only comparatively high, but also a serious hazard is created should a fire once get started in the machine. In England machines have been designed using water as a cooling medium without any marked success.

The advent of closed air-cooling systems for generators opened up the possibilities of using other gases than air as the cooling medium, such as carbon dioxide, nitrogen or hydrogen. The last-named in the present stage of development seems to have advantages that make it superior to others if the explosion danger can be eliminated. Experiments have shown that probably the explosive hazard has been overestimated, although further investigations along this line may be desirable. It has been found impossible to ignite a mixture of air and hydrogen containing more than sixty-five per cent hydrogen. This would allow for a thirty-five per cent air infiltration into the machine before the danger zone would be reached. Since the pressure could be automatically maintained in the machine slightly above atmosphere, air infiltration can be prevented. On the other hand, devices may be used to give an alarm automatically before an explosive mixture has been obtained.

In the application of pulverized coal to power plants the explosion hazard is probably greater, if proper precautions are not used, than apparently exist with the quantity of hydrogen that would be used in the cooling system of a high-speed alternator. Means for preventing pulverized-coal explosions have been so thoroughly worked out and applied that this danger has practically ceased to be discussed.

Investigations have shown that even if an explosive mixture of hydrogen and air is ignited in a machine, means can be provided to prevent its doing injury to the equipment. However, this does not mean that hydrogen should be adopted as a cooling medium without thoroughly working out safe methods for its application, or the results may be as disastrous as some of the early pulverized-coal explosions.

Hydrogen is a non-supporter of combustion, therefore its use as a cooling medium eliminates the fire hazard in generators. Its use will greatly decrease windage losses in the machine, which would result in about one per cent increase in efficiency. On account of its better thermal qualities, a machine using hydrogen as a cooling medium will carry about thirty per cent more load than when air is used. This latter effect is one that may in many cases be taken advantage of in existing machines where they are supplying low-power-factor loads. In such cases the turbines are underloaded, and if some satisfactory means can be found to cool the generators, the useful power output of the station could be materially increased without adding new machines.

Emphasis Swinging from Thermal Economy to Low Fixed Charges

IT IS difficult for the average human mind to see things in their correct relative proportions. Like the eye, interest has an inherent tendency to center on one particular object or small group of objects, while the rest of the landscape fades into a smear. To the botanist wandering through the woods, a glimpse of some rare flower may obliterate the entire forest. The same human trait is found in the field of power-plant design. While it has long been an axiom with designers that the sole object to be sought is the lowest over-all cost per delivered kilowatt-hour, consistent with reliable service, actual designs have not always exemplified the application of this principle, largely because concentration on certain factors has resulted in neglect of others.

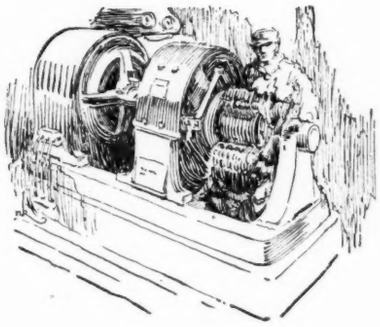
The cost of a delivered kilowatt-hour comprises four major elements: Operating labor and superintendence, maintenance, fuel costs, fixed charges on investment. Each of these, in turn, is composed of or affected by a thousand and one small items. The trend of these four major elements during the last twelve years, as brought out in an illuminating paper entitled "Latest Design and Practice in Power Plants," presented at the recent annual meeting of the A.I.E.E., is of great significance. Curves were drawn representing the average for a large number of typical new stations of 60,000-kw. capacity and higher. According to these curves the total cost per kilowatt of net station sendout was five mills in 1913, consisting of two mills each for fixed charges and fuel costs, and one-half mill each for operating labor and maintenance.

During the entire period from 1913 to date these last two items have remained practically constant. The chief interest therefore centers in the trend of fixed charges and fuel cost. From 1913 to 1920 these two items rose sharply, and from then on to 1923 fluctuated about the 1920 level of 4¼ mills each. During the period from 1913 to 1923 the curves for fuel costs and fixed charges remained remarkably close to each other, one being ahead one year and the other the next. The total cost in the period from 1920 to 1923 averaged about 9½ mills.

From 1923 to date it dropped to eight mills. Yet there was no appreciable change during that period in fixed charges or in maintenance or operating labor. The saving, as shown in the curves referred to, was entirely in the fuel cost per kilowatt-hour, which fell from 4¼ mills in 1923 to 2¼ in 1925. This enormous drop reflects great credit on the technical skill that has been applied to such subjects as boiler and turbine design, heat balance, high steam pressures and temperatures. It has been accomplished largely through the subordination of all other questions to that of fuel economy, which subject has had the undivided attention of some of the best engineering brains in the country. The fact remains that with fixed charges running at 4¼ mills and fuel costs at 2¼ mills, the big opportunity for saving (note that this applies to new central stations of sixty thousand kilowatts or over) now lies in reducing the fixed charges, which in turn means cutting down the station cost for a given yearly kilowatt-hour output. Obviously, the load factor, which lies largely outside of the control of the designer, has an enormous influence on fixed charges, but starting with a given load factor it is within the power of the station designer to effect a considerable saving in fixed charges without producing counterbalancing increases in fuel costs.

Since the mind somehow cannot concentrate effectively on all phases of a subject at the same time, it is good that there should be a swing now toward concentration on the reduction of fixed charges. A distinct contribution to constructive thought along this line was made in recent articles (May 19 and July 21) by Vehling and Crawford. A third article, "Improving Financial Efficiency by Elimination of Unnecessary Initial Expense," to appear in an early issue, will deal with certain factors that have more to do with the cost of power than is generally realized.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for June will be announced next month.

Factors in the Economical Operation of Boiler Plants

To insure economical operation of a boiler plant, we must determine the actual every-day performance and compare it with some established standard. To determine the daily results, it is necessary to know the amount of water being made into steam from each pound of fuel. We should know the temperature of the feed water entering the boilers, the steam pressure carried and the approximate heat value of the coal. It is best to use a recording thermometer and recording pressure gage. This gives a record for comparison and is a check on the firemen.

When you determine the cost of running a business, you count the dollars carefully. To determine how much coal you are burning, you must weigh your coal accurately. Records should be kept in as simple and accurate method as possible under your particular conditions of plant operation and design. Accurate records of the steam produced are better than records of water being fed to the boilers. The reason for this is that there is liable to be leakage in the feed lines and deductions have to be made for the boiler blowdown. Steam-flow recording meters should be used to record the amount of steam being produced. Means must be provided for checking up all recording instruments and keeping them calibrated. A reliable recording and indicating CO_2 instrument should be connected to each boiler together with a recording thermometer for determining the temperature of the flue gases leaving each boiler. Draft gages for determining the amount of draft over and under the fire should be provided.

The heating surface must be kept clean both inside and out. Flues and tubes must be blown and scraped. Blowing of flues is of little value so long as they are caked. They must be thoroughly cleaned first. Scale and deposits on the inside of the heating surface from impure feed water will cause burning and bagging of tubes and sheets, as well as the waste of fuel.

Every industrial boiler plant should be run in a businesslike manner. Records should be kept not only to show the operating condition of the plant, but for computing the cost per unit of output. No matter what you are manufacturing, you should know the cost of the steam entering into your products or used for power. It is up to the engineer to produce such records, so the management will know how efficiently the boiler plant is being operated and the cost department should know what it costs to produce the steam and power. The engineer of today must have training and ability to operate his boiler plant in the most economical manner. He must be qualified to show the management why certain instruments are essential to the economical operation of the plant. When a boiler plant is being tested for efficiency, the results are always better than when no test is being run, so we should equip our plants so as to keep a boiler test going on continuously. There are two important questions demanding correct answers: At what efficiency does the plant operate? What is the fuel cost per 1,000 lb. of steam?

Norwich, N. Y. W. S. EVERHAM.

Steam-Valve Actuating Mechanism Simplified

In an endeavor to simplify the actuating mechanism of the valve that controls the admission of steam to the cylinder of our underfeed stokers, by materially reducing the number of working parts and providing

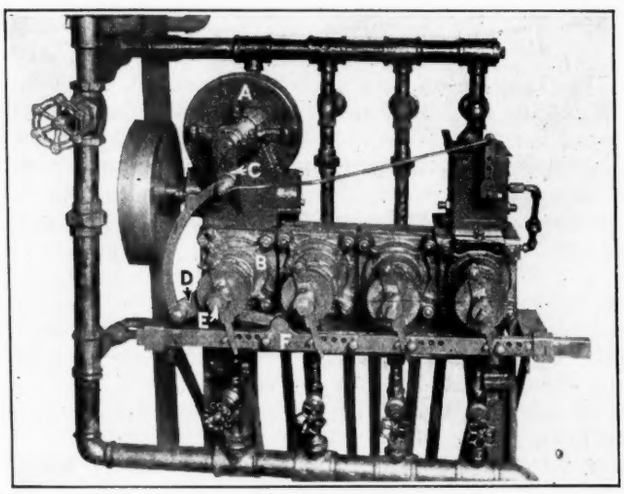


Fig. 1—Assembly of valve actuating mechanism

an independent adjustment for each valve, I developed the attachment shown in the illustration.

Referring to Fig. 1, a worm reduction gear *A* driven through a belt is mounted above the steam valve *B*. The outer end of the worm gear shaft carries the crank *C* which is connected through a link to a bell crank *D* carried on the valve stem *E*. The other end of the bell

crank is connected through a short link to a sliding bar *F* which in turn causes the valves to rotate by means of a pawl engaging a ratchet wheel mounted on the valve stems.

The sliding bar *F* is provided with a series of holes and fitted pins, by means of which independent adjustment is made of the rotating movement imparted to each valve.

The advantages of this attachment are that it is

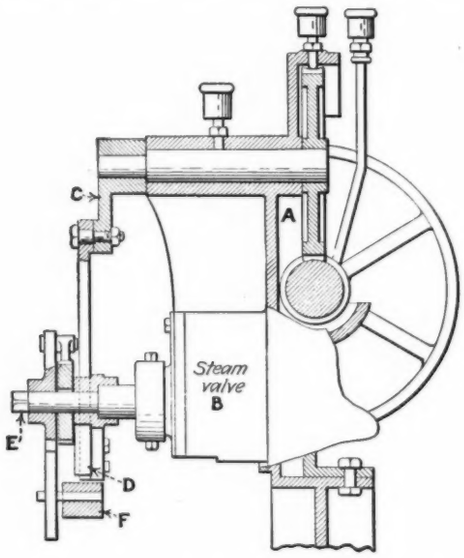


Fig. 2—Section of reduction gear and actuating links

positive in action and that the travel of each valve is visible at all times. It has been in use in our plant for about two years and has given good results.

Pittsburg, Kan. WILLIAM J. LAPWORTH.

Combined Steam Generator and Accumulator to Reduce Banking Losses

Banking boilers is one of the important losses that affects the over-all efficiency of the steam plant. There are different requirements for banking which may be classified under two principal divisions: Banking the boiler at night when there is no load; banking for emergency in case of breakdown and banking for emergency in case of an increase in load.

The night banking does not require as much consideration as the emergency banking, because it cannot always be dispensed with and because it is not necessary to keep the boiler and brickwork very hot; also the damper can be shut off sufficiently to keep the fires burning slowly, consuming comparatively little fuel.

The emergency banking may be necessary for breakdown only or for breakdown and increased load. In plants where the load is steady, the banked boiler will serve for the purpose of boiler breakdown only.

Taking the case of the central heating station, the emergency banking serves both purposes, permitting the meeting of the load when one of the boilers breaks down or when the additional load is required.

Considering the increase in load, we can take for example a large heating plant where a change of one degree in the outside temperature increases the steam demand 4,500 lb. of steam per hour. The temperature may change 10 deg. in an hour, which would require an additional 45,000 lb. of steam per hour. Although the change in load does not exactly follow the change in the outside temperature due to the heat capacity of the building walls, it will, however, require a sufficiently large portion of the load that cannot always be taken care of with the boilers in use, making it necessary to put a banked emergency boiler into service.

For these reasons a boiler banked for emergency in case of breakdown or for an increase in load cannot be kept banked with a light fire in the furnace, but requires a sufficiently good fire to hold the boiler and brickwork hot enough to allow the boiler to be put into operation in the least possible time. For this reason the consumption of fuel with emergency banking is much greater than with ordinary night banking.

Further consideration of banking in the case of a central heating station shows that at night, when the plant load drops considerably, the emergency boiler is not required and the fire is permitted to go out, the boiler being placed in operation again the next morning. Part of the heat retained by the boiler and setting is lost during the night, making it necessary to burn a certain amount of fuel to warm it up to the regular operating condition on the following morning. Therefore the losses from emergency banking are due to the burning of fuel during the day to keep the boiler ready for service and to the starting and stopping of the boilers during the night.

To prevent these losses and to have practically the same advantages as the banked emergency boiler, a steam boiler that can be operated either as a steam generator, as an accumulator, or both might be used.

The combined generator and accumulator may consist of a Lancashire type internally fired boiler equipped with a steam atomizing fuel-oil burner. The internal construction of the boiler should be similar to that of a steam accumulator so as to serve both purposes.

The operation will be as follows: When no extra load is required in the plant, the combined generator and accumulator boiler will act as a steam accumulator and any drop in pressure due to an increase in load will put it into operation, regenerating its stored steam. During a breakdown requiring an emergency repair or with a slight change in load the regenerating effect alone will be used. If, however, considerable time is required to make the repairs or the load increases, the oil-burning unit will be put into operation, and the boiler will then assist in maintaining the load until another boiler can be placed in operation. This type of boiler having no brickwork and equipped with oil burners can be put into operation quickly, especially when all the water it contains is at steam temperature.

The radiation losses of the combined generator and accumulator of the Lancashire type will be small since the firedoor and boiler damper will be tightly shut, keeping the air from circulating, which serves as an insulator. The brickwork and insulating material may be arranged to reduce the radiation losses to a negligible amount. At night it is not necessary to stop or start this combined boiler as compared with the emergency boiler, and therefore the losses due to emergency banking should be reduced to a minimum. Comment from other readers on this subject may prove of value. Z. KOGAN.

Chicago, Ill.

Comments from Readers

Safety-Valve Discharge Piping

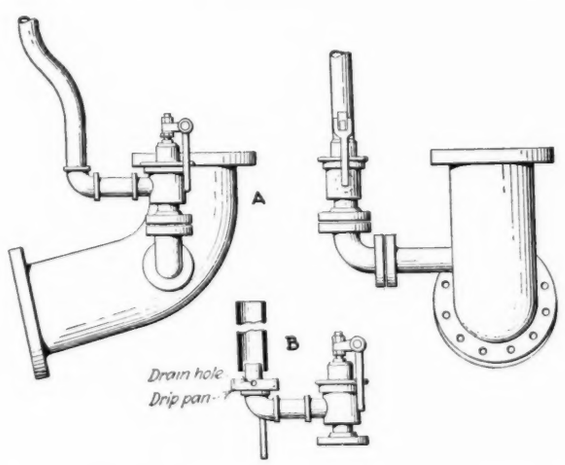
Having read the letter by G. A. Phinney on "Safety Valve Discharge Piping," in the June 16 issue, it occurred to me that the method shown herewith of connecting the discharge pipe may be of interest to other readers.

Some five years ago I was supervising an installation of superheaters that required the application of twenty 3½-in. safety valves to the superheater headers. Each of the safety valves was furnished with screwed outlet and was attached to an outlet cast on the special fitting with an elbow, as shown at *A* in the illustration.

The escape pipe was connected to the valve through an elbow and nipple, the pipe having a slight offset and then continuing upward for about twenty feet. The pipe was securely braced for the purpose of taking the weight off the safety valve.

After the boilers were placed in operation, considerable trouble resulted from non-performance of the valves; as a result the manufacturer's engineers were called in to locate the trouble.

The engineers requested that two of the valves be removed and returned to the factory for inspection. Subsequent report stated that there was nothing dis-



Original and improved arrangement of connecting discharge piping

closed at the factory that would prevent the proper functioning of the valves. Upon re-installation of the valves the trouble continued, and it was finally concluded that the weight of the escape pipe, in combination with the expansion at the time of blowing, caused a strain on the body of the valves tending to distort them.

The manufacturer advised that the escape pipe be applied as shown at *B*. It will be seen that instead of the pipe being screwed directly into the elbow attached to the valve, it is supported independently. A short nipple fitted with a drip pan somewhat larger than the escape pipe is placed in the elbow and extends a few inches into the pipe.

This arrangement has proved satisfactory, as it removes all weight from the valve and permits free expansion when the valve blows. E. C. GRIEF.

New York City.

How the Valve Setting Has Improved with the Aid of the Indicator

In reading the article in the May 26 issue by J. F. Nagle, on "How the Valve Setting Was Improved with the Aid of the Indicator," I notice an error which, I

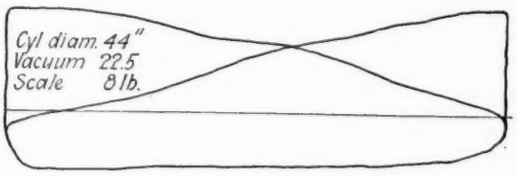


Diagram from low-pressure cylinder

believe from my observations, is not an uncommon one.

Referring to Fig. 3 of this article (reproduced herewith), which is a diagram from the low-pressure cylinder, Mr. Nagle says: "The diagram shows piston leakage, as indicated by the rise of the expansion line, which no doubt accounts for the low vacuum." Now if we analyze the conditions in the cylinder during expansion, we will find that in this case we have vacuum on one side of the piston and pressure on the other, and with a leaky piston the expansion line would fall below the true expansion line instead of rising above it. The diagrams as given show no indication whatever of a piston leak, but clearly indicate leaky steam valves, which in turn would cause a poor vacuum.

Los Angeles, Calif. J. D. CARR.

Problems of the Operating Engineer

The contribution of C. A. Hanna in the April 7 issue on "Problems of the Operating Engineer" introduces an interesting subject to many plant engineers, partly because a great many really good engineers are in the same predicament as Mr. Hanna's friend. This problem, seriously considered, is a simple one and the solution is in the hands of the operating engineers themselves.

In the first place Mr. Hanna's friend has evidently accepted a most responsible position, carrying the responsibility not only of the success of the plant, but also the commercial success of the whole concern and its dividends without any authority whatever, as he cannot discharge or replace a fireman whom he has proved inefficient, and we also assume he cannot purchase a pint of oil. Consequently, the position has been an impossible one from the start, and the engineer who

undertakes a position in this manner has only himself to blame, and the expense incurred, in moving and purchasing a new home, is simply a bad investment on his part and must be treated as such.

Evidently, when obtaining the position the directors must have considered him a valuable engineer, otherwise they would not have given the additional $900 over his predecessor, and why he did not embrace this opportunity and at once consolidate his position by a properly drawn up agreement of his duties, responsibilities and authority, is difficult to comprehend. Usually, this opportunity, once missed, does not return, but our friend had a second chance presented to him when his first year's results came up for consideration. To convert a loss of $3,000 into a profit of $7,000 gave him a talking point that would have convinced any body of directors that they had a live engineer, and no doubt if the truth were known, the real trouble as far as this engineer is concerned is that the "Laurel Leaves" handed out on this occasion have "gone astray" and may be found round about the manager, who prefers any sort of firemen and counts efficiency by length of service.

After careful consideration of these facts and the difficulties of obtaining satisfactory references and the expenses of moving, I think it is a mistake for this engineer to throw over the position and that it would be to his advantage to accept the reduction in salary and "start over again," and maybe what at the moment appears a calamity may become a blessing. But in accepting this reduction he must embrace the opportunity to have his whole position properly defined and put all his facts before the directors. He might also make a definite statement "that with proper authority" he can make the concern pay and pay well, also adding "that without it, no matter how large a salary they offered, he would not retain the position."

If the directors are a level-headed set of men without prejudice or favor (and we may presume they are), I feel sure our friend will be given the opportunity to recover the aforementioned "Laurel Leaves" and will no doubt wear them with honor to himself and his firm.

If he fails to get reasonable authority, by all means let him clear out and seek comfort in the fact "that the job is more suitable for a brother of the negro fireman, and for his peace of mind he is best out of it." In conclusion, if we sum up this problem we find it is very much like the "old confidence trick." The rosy prospects placed before the victims gull them into a false sense of security, and everything is accepted as gospel without any inquiry.

F. P. TERRY.

Belfast, Ireland.

Another Internally Fired Boiler

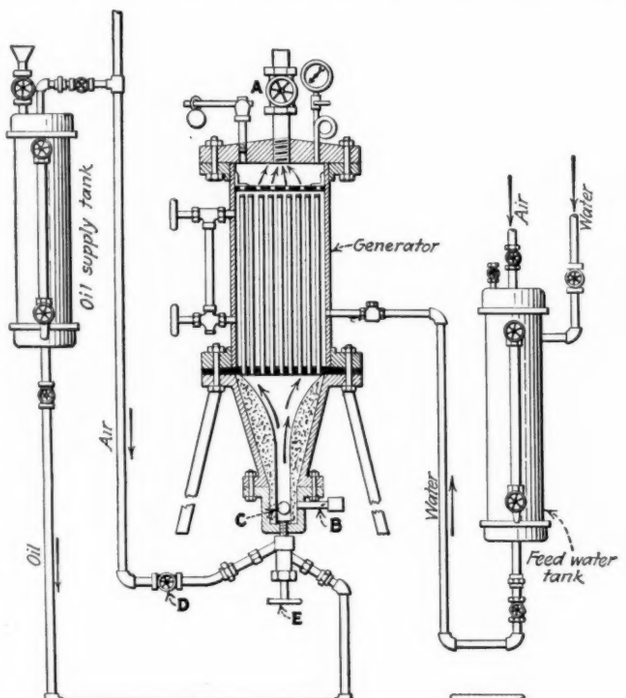
I notice in the May 12 issue a description of an internally fired boiler, which was designed by James N. Seymour in 1916.

An article in the *Engineering Magazine* for 1906 describes a type of internally fired boiler which was designed by the writer about nineteen years ago. This boiler was constructed in the engineering laboratories of the University of Illinois and operated for several months. The products of combustion and steam were used to drive a small turbine pump, much to the detriment of the turbine blading.

The temperatures as used were in the neighborhood of 1,500 deg. F., and the pressure was approximately 150 pounds.

From the results of the tests, using kerosene as a fuel, it was shown that a thermal efficiency of about 20 per cent might be expected. A brief outline of the principal features of this boiler, extracted from the article previously referred to, follows:

Referring to the illustration, the apparatus consisted of a generator, oil and feed-water supply tanks and a nozzle for spraying the air and oil. The generator was built of 12-in. extra-heavy pipe fittings, and the tubes, 73 in number and $\frac{5}{8}$-in. diameter by 22 in. long, were expanded into the lower tube sheet, the upper end being left free. Into the upper end of each tube was dropped a $\frac{3}{8}$x1$\frac{1}{2}$-in. bolt with a perforated plate placed directly



Assembly and detail of internally fired boiler

above. The object of this arrangement was to prevent the water, lying around the tubes, descending through the tubes into the combustion chamber in case of violent ebullition. The products of combustion pass up through the tubes, mix with the steam and pass with it out through the valve *A*. The combustion chamber was lined with a mixture of burnt firebrick ground and united with fireclay. A $\frac{3}{4}$-in. nipple *B* fitted with an eyepiece was provided for observing the combustion. Oil from the supply tank was forced into the combustion chamber by air pressure admitted to the top of the tank. The feed water was also forced into the generator in a similar way.

The manner of operating the generator was as follows: Compressed air at 110 lb. gage was supplied to nozzle, oil tank and feed-water tank. Kerosene was used for fuel. Two methods of starting were used, but the one outlined herein was the more satisfactory.

First the valve *A* was opened and the pipe plug *C* removed. Then a small quantity of gasoline was poured into the combustion chamber and ignited by means of a torch. The air pressure was then turned on through the nozzle by opening the valve *D*. After the gasoline had burned for a few seconds, kerosene was slowly turned on by opening the valve *E* and regulating it to give a bright steady flame. After the flame had continued steadily for a few minutes, the pipe plug *C* was replaced and the pressure of 100 lb. gage was obtained in the generator, by throttling down the gases escaping through the valve *A*.

After pressure was obtained in the generator, the combustion was regulated by observing the flame through the eyepiece *B* and manipulating valves *D* and *E* until the flame was of a brilliant white. In this way practically perfect combustion was obtained. After the generator had been in operation for about thirty minutes, steam would begin to come off and the pressure rise so that it was necessary to open gradually the valve *A* in order to prevent the generator pressure rising to that of the compressed-air supply.

The great disadvantage of the apparatus is the large amount of air that must be compressed to a pressure higher than the generator pressure, combined with the fact that the products cannot be used successfully in condensing equipment, and in addition to this there is likely to be considerable corrosion. C. M. GARLAND.

Chicago, Ill.

Units of Evaporation and Capacity

The Foreword in the June 2 issue, entitled, "Wanted, Two Names," suggested the adoption of some simple term to represent the unit of evaporation and also the unit of capacity, inasmuch as leaders in American boiler practice are adopting the absorption of 1,000 B.t.u. as the unit of evaporation instead of the heat of evaporation from and at 212 deg. F. It was also pointed out that with a term to represent the unit of capacity, instead of saying that a boiler had a capacity of so many horsepower we would say that it had a capacity of so many ——s and to find the number of ——s we would divide the number of B.t.u. that it absorbed per minute by 1,000 instead of the number it absorbed per hour by 33,479.

Power has received a number of replies suggesting names for the two units, and these have been grouped and are presented herewith. The term kilo tu has been proposed by Henry C. Meyer, New York City, as a name for the unit of evaporation, this being an abbreviation for kilo thermal units or 1,000 B.t.u. Somewhat similar terms, "kilo-but" and "kilo-unit" are suggested by J. M. Robb, Moline, Ill., and W. L. Austin, Oklahoma City, Okla., respectively.

E. L. Crowe, Chicago, Ill., proposes the name "vap" as having the advantage of brevity and suggesting the character of the unit. W. P. Lambert, Charleston, S. C., suggests the term "univap" and "univaps." Applying the latter term we would say a boiler was so many univaps capacity, just as we say a generator has so many kilowatts capacity. The term vapor has been suggested by F. C. Winter, Charlotte, N. C., as a name for the unit of evaporation as it is short and can be visualized by the student in the following manner: As the unit of evaporation is the absorption of 1,000 B.t.u., the student can visualize a reaction taking place on one unit of water being expanded into a gas through the absorption of 1,000 British thermal units. For the unit of capacity he suggests the term "vapower," the word power being used in conjunction with the word vapor as they are closely related. The term vapower has also been proposed by G. B. Preston, New York City, to cover both units.

The term "therm," which is in general use in England as the unit for the sale of gas, is proposed by J. C. McCabe, Detroit, Michigan. In this case the "therm" is 100,000 B.t.u. and to use 1,000 B.t.u. as a basis it can be termed a "centitherm," or 10,000 B.t.u., a decitherm, etc. Following in this same line is the suggestion of Raines Kessler, Atlanta, Ga., with "kilotherm" and "kilotherm"-hour, to represent the units of evaporation and capacity respectively, the kilotherm representing 1,000 heat units. Another contributor suggests similar terms but would have the "therm" stand for one B.t.u. per minute and a "kilotherm" equivalent to one thousand B.t.u. per minute. W. D. Halsey, Hartford, Conn., proposes kilotherm to represent the unit of absorption of heat, but for the unit of capacity he suggests borrowing a page from electrical terminology and selecting a name of one of the pioneers in the use of steam and incidentally suggests the name of "Savery" for to him, it is believed, belongs the honor of first putting steam to industrial use.

Walter H. Stoelzer, Brooklyn, N. Y., suggests the terms, "thermil" and "thermic," the former to represent the unit of evaporation or $\frac{\text{No. of B.t.u.}}{1{,}000}$ and the latter the unit of capacity or $\frac{\text{No. of B.t.u. per hour.}}{1{,}000}$

George H. Gilbert, Germantown, Pa., also proposes the use of the term "therm" and refers to the definition given in the Standard Dictionary: "Therm—A unit of thermal capacity, variously defined as the equivalent of the gram calorie, the kilogram calorie and one thousand kilogram calories. Of these values the one commonly accepted is that which makes the therm equal to one gram calorie."

G. R. Pratt, Winnipeg, Canada, is of the opinion that in many respects it would be best, from a final user standpoint, if coal were made the basis instead of the boiler, and he suggests the use of the steam unit 10,000 B.t.u. to be called Yew or Y. The reason for selecting 10,000 is in order to bring it within reason or understanding of 1 lb. of coal. Dividing the B.t.u. value of coal (in thousands of B.t.u.) by 10,000 will give the unit Y value of the particular coal. If a certain coal contained 12,500 B.t.u. per pound, Y would equal 1.25. R. H. Rogers, Schenectady, N. Y., suggests the term "Munit," this word being made up of the capital M for one thousand combined with word unit representing British thermal units. R. Manly Orr, Vancouver, B. C., suggests stam for the unit of evaporation and for the steam rate of capacity unit the term "stamra." To the terms already mentioned might be added the term kal, which has been used for some years by the New York Steam Corp., New York City, to represent 1 lb. of water evaporated into steam or 1 lb. of steam condensed into water, no particular steam pressure or water temperature being mentioned. There is also the term "myriawatt" suggested some years ago by the late H. G. Stott and now in use to a limited extent. It is based on the fact that the heat units equivalents of a kilowatt-hour and a boiler horsepower bear very nearly the relation of 1 to 10; hence the "myriawatt" represents 10 kw.-hr. or 34,120 B.t.u.

Questions and Answers

Conducted by

Franklin Van Winkle

Knocking of Duplex Pump

What would cause a knock in one of the steam cylinders of a duplex pump at each end of the stroke? *C. S. T.*

Striking results from insufficient cushion on the exhaust or may be due to a loose piston. When due to insufficient cushion, the knock occurs at the extreme end of the stroke and the loss of cushion may be due to leaky piston rings that do not hold the exhaust ports tight when the piston is near the ends of its stroke; or if the pump is provided with cushion valves, they may leak so badly as to lose the cushion. If the knocking occurs only at high speeds or when pumping against a low pressure with the throttle valve nearly closed, the cushion may be lost from the compression lifting the slide valve off its seat.

Causes of Excessive Flue-Gas Temperature

What are causes for excessively high flue-gas temperature? *C. S.*

Excessive fluge-gas temperature may be due to soot outside or scale inside of the heating surface, insufficiency of heating surface, forcing the fire, poor circulation of the boiler water, after burning of the furnace gases, and also may result from supplying the furnace with too much excess air.

Air Required for Burning Coal

Analysis of a sample of coal shows its composition by percentages to be as follows: Carbon, 77.43; hydrogen, 4.8; oxygen, 6.53; sulphur, 1.49; nitrogen, 1.28; and ash, 8.47. What number of cubic feet of air would be required for combustion of a pound of the fuel? *S. M. C.*

The theoretical amount of air required for the complete combustion of coal can be computed from the formula

$$\textit{Lb. of air per lb. of coal} = 11.52\,C + 34.56\left(H - \frac{O}{8}\right) + 4.32\,S,$$

where C, H, O and S are the proportional parts by weight of carbon, hydrogen, oxygen and sulphur, from the ultimate analysis of the coal. Hydrogen combines with eight times its weight of oxygen, therefore it is assumed that hydrogen equivalent in weight to one-eighth of the oxygen in coal will not require oxygen from the air. Substituting the given proportions of C, H, O and S, the formula becomes

$$\textit{Lb. of air per lb. of coal} = 11.52 \times 0.7743 + 34.56\left(0.048 - \frac{0.0653}{8}\right) + 4.32 \times 0.0149 = 10.36\ \textit{lb. of air}$$

and as 1 lb. of air at 62 deg. F. has a volume of 13.14 cu.ft., 10.36 lb. would occupy a volume of $10.36 \times 13.14 = 136.1$ cu.ft.

This is the theoretical quantity of air that would have to be admitted to the furnace for every pound of coal burned. In practice it is necessary to admit more air into the furnace than actually required to burn the coal, in order that each atom of carbon will meet an abundance of oxygen. The amount of excess air thus required varies from 25 to 200 per cent, depending on the type of furnace, manner of stoking, draft and other operating conditions.

Submerged Piston vs. Straightway Pumps

What are the relative advantages of submerged-piston and of straightway pumps? *N. F.*

Submerged-piston pumps, which have both suction and discharge valves on the upper side of the water cylinder, have the defect that there is reversal of the water in the ports at every stroke. The water must be brought to a full stop and then must be set in motion through the ports in the opposite direction. While this is of little consequence in small pumps, it may cause such disturbance in large pumps as to require running them at moderate speeds. However, the submerged type is preferable for handling hot water and for condenser service. In a straightway pump the suction valves are placed in a valve chamber on the underside of the pump cylinder and the water flows through the pump in a practically unchanged direction. When the plunger or piston comes to rest at the end of a stroke, the water does not necessarily stop, but may continue to flow through the pump until its inertia is overcome by the head pressure.

Cause of Flat Spots on Collector Rings

If the bearings of a 60-kw. 1,100-volt alternating-current generator are badly worn, could this be the cause of flat spots on the collector rings? *E. H.*

Badly worn bearings on the generator could be the cause of flat spots on the collector rings. One of the most common causes for flat spots on collector rings is vibration, which makes the brush break contact with the rings, producing a flat spot on the surface. This condition is particularly troublesome if the vibration is of a periodic character, breaking the contact of the brush repeatedly at the same spot on the ring. It may result from unequal expansion of the ring, destroying its true cylindrical form as the machine warms up. This fault is most likely to occur with spoked rings of light cross-section. In some cases the trouble may be corrected by grinding the rings after they have been heated up to operating temperature. It is well, where possible, to perform this grinding operation at the full running speed of the machine, as at this speed there

may be a distortion that does not exist at lower speeds.

Other sources of troublesome vibration are brushes too loose in the holders, insecure mounting of brush-holders, loose bearings, pounding of reciprocating engines, and a mechanically unbalanced rotating element. The remedy in all these cases is to correct the mechanical fault. It is wrong, as sometimes done, to try to overcome a mechanical fault by the use of an abrasive brush. Chattering of the brushes is a form of vibration that is frequently a source of spotting. It may be due to loose brush-holders or too much clearance between the brush and the holder.

Flat spots on rings sometimes result from hard or soft spots in the material composing the rings. This is a somewhat common fault in cast-iron rings, and spongy spots are of rather frequent occurrence in bronze rings, especially where the composition is very high in copper.

Current left on when the machine is standing is a less common cause of flat spots than those mentioned, but one that may sometimes be found even with field rings, where the current might not be thought to be excessive. The temperature attained at a brush contact on a stationary ring is higher than might be realized at first thought.

Surges of current due to short-circuits, sudden peak loads, hunting between machines operating in parallel, or static disturbances, are likely to produce small burnt spots on collector rings, which, if not cleared off, may develop into spots of considerable size.

Locating High Side of Eccentric

How can the high side of an eccentric be determined to know when it is vertical or when it is on the dead center line of the eccentric rod? *F. B. G.*

Make a tram of sheet steel, as shown at *A* Fig. 1, having a notch *N* at one end and a hole *H* large enough to receive the pointed end of a scriber. With the notch of the tram placed against the shaft and point of the scriber in the hole *H*, draw the arcs *EF* and *GH* on

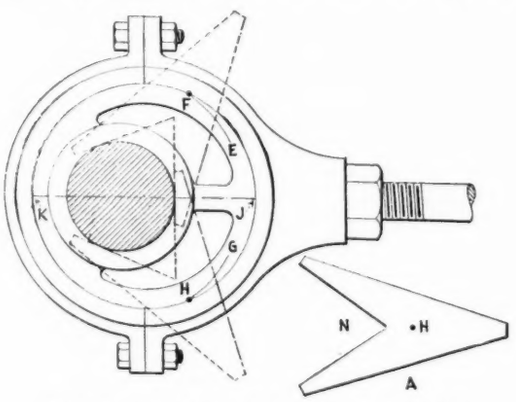


Fig. 1—Finding high side of eccentric

the eccentric, ending at the points *F* and *H* at the shoulder of the eccentric. Then with a pair of dividers locate a point *J* on the edge of the eccentric equally distant from points *F* and *H*. In a similar manner the point *K* may be located. The point *J* is farthest away from the center of the shaft and the point *K* is nearest the center of the shaft, and a line *KJ* represents the position of the eccentric. The joint in the eccentric strap usually is at right angles to the eccentric rod, and when that is so the eccentric may be placed approximately at right angles to the eccentric rod by turning the eccentric until the point *J* or point *K* comes opposite to the joint. When the joint is not at right angles to the rod, as shown in Fig. 2, or it is desired to determine a position at right angles to the center line of the rod, provide a tram of steel wire with pointed ends as shown at *L* and make a punch mark *M* in the side of the eccentric rod opposite its center line. Then with one point of the tram in the mark *M* as a

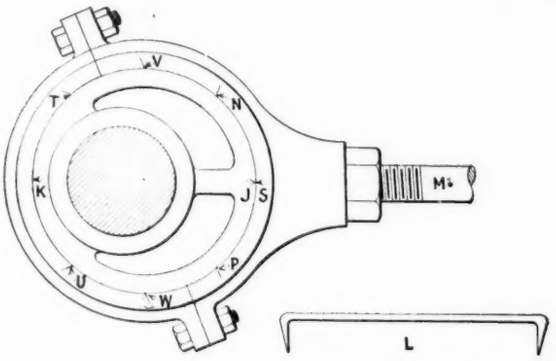


Fig. 2—Finding position for eccentric at right angle to eccentric rod

center, draw arcs on the strap intersecting the edge of the strap at *N* and *P* and with a pair of dividers, locate a point *S* on the edge of the strap equidistant from *N* and *P*. Then when the point *S* is opposite to the joint *J* or *K* as determined at Fig. 1, the eccentric is on dead center. With dividers set to the length *NS* strike arcs from *K* and locate marks *T* and *U;* then locate the point *V* equidistant from *T* and *N* and *W* equidistant from *U* and *P*. Then when the point *J* corresponds with either the points *V* or *W*, the eccentric will be at right angles to the new center line of the eccentric rod.

Standard of Evaporation

Why are performances of boilers rated as equivalent evaporation or evaporation from and at 212 deg. F.? *L. D.*

Boiler performance consists of transfer of heat to the feed water, and for the purpose of comparing evaporative results attained by different boilers, it is necessary to reduce the actual conditions of feed-water temperature, pressure and quality of steam to a common standard. The standard conditions that have been in use for many years are feed water at the temperature of 212 deg. F. and evaporation from that temperature into dry saturated steam at the same temperature, which then would be at atmospheric pressure, or evaporation equivalent to evaporation "from and at 212 deg. F." Under these conditions each pound of water for its evaporation would require the latent heat of evaporation, or 970.4 B.t.u., so that the equivalent evaporation from and at 212 deg. in any case is the number of pounds of water evaporated under the actual conditions, multiplied by the B.t.u. received per pound, divided by 970.4 B.t.u.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication, and for the inquiries to receive attention.—Editor.]

Suggested Rules for the Care of Power Boilers*

Proposed as an addition to the A. S. M. E. Boiler Construction Code

IT IS the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Committee.

IV—Rules for the Prevention of Direct Causes of Boiler Failures

(Continued)

Feed-Water Treatment

General

C-210. The treatment of boiler feed-water is a specialized branch of chemical engineering. The average operating engineer is not qualified to undertake this phase of the work.

Consequently, in all cases where feed-water treatment is necessary, boiler-plant operators should place their problems in the hands of competent technical specialists, abiding by their advice.

Some of the distinct characteristics of feed-water and means for treatment can be found in the Appendix to this Code, but the application of such treatment principles should not be undertaken without competent advice.

C-211. All boilers using feed waters containing calcium sulphate, combinations of sodium chloride and magnesium sulphate, magnesium chloride or sodium or magnesium nitrates, organic acids or mineral acids, should be inspected for scale, or corrosion, or both. Boiler operators shall watch their raw-feed supply to guard against the possibility of corrosive elements becoming mixed with the water.

C-212. To protect the main supply pipes and pumps during periods of acidity, slacked or commercial hydrated lime containing a high percentage of calcium oxide or soda ash should be fed continuously into the suction pipe, at the source, to make the water slightly alkaline.

Rain water is corrosive, and especially so when it comes from roofs of buildings near manufacturing centers. In such cases it will contain more or less sulphur dioxide in addition to carbon dioxide, oxygen and other corrosive agents, making its use dangerous unless proper correctives are applied.

C-213. Distilled water may be corrosive on account of the oxygen and carbon dioxide content, therefore, special care should be taken that these gases are removed if found in objectionable quantities.

C-214. Feed waters which are contaminated in any way with sea water may cause corrosion and scale; if objectionable in quantity, proper means should be applied to overcome same.

Boiler Compounds

C-215. No materials should be used for the prevention of scale, corrosion, and priming without an exact understanding of their composition, the nature of the objectionable materials in the feed water to be removed, and the influence the resulting products and unnecessary substances in such materials may have in causing unsatisfactory operating conditions.

C-216. Graphite should be used with caution in painting shells and other interior surfaces as it tends to choke up connections to draft regulators and steam gages.

C-217. Kerosene should not be used in boilers for any purpose as it is likely to leave behind inflammable gases which have caused dangerous explosions in the past on the introduction of naked lights into the boiler.

When kerosene is employed for cleaning the blades of steam turbines, provisions should be made for discharging the used portions direct into the sewer or other waste.

Heater Equipment

C-218. Heat aids in precipitation of impurities, therefore it is advisable to raise the temperature of the feed water as high as is consistent with local plant conditions.

C-219. Where gas corrosion is definitely established and it is difficult to maintain the feed water entering the boilers at a minimum of 200 deg. F., and all other means have been exhausted, it is recommended that a live-steam booster connection be used under control of a thermostat, in which case a temperature recorder should be attached and used and a relief valve be placed and set so as to prevent the building up of excessive outlet pressures.

C-220. Where open heaters are used, these should be well vented to the atmosphere for carrying off corrosive gases. A separator should be provided for removing any oils that may exist in the exhaust steam for heating the water, and blow-down connections of ample size should be provided for discharging solid materials that may settle from the water.

Treatment Regulation

C-221. When boiler waters show the excessive formation of scale or the effects of excessive corrosion, appropriate methods should be adopted for the prevention of these conditions, and such tests and treatments as are directed by the supervising engineer should be performed.

C-222. Where the correct internal treatment of feed water with chemicals causes accumulating chemical precipitates to interfere with the full delivery of clean steam, the chemical treatment of such a water should be made in separate equipment, outside the boiler, or as directed by a competent chemical engineer.

C-223. Where feed waters are chemically purified in equipments external to boilers, such equipments should be of ample size to permit the maximum precipitation and separation of natural, suspended, scaling, and corroding materials from the feed water before such a water enters the feed equipments and boilers.

C-224. Proper supervision shall control the operation of any water softener.

C-225. Where treatment of feed-water is required, the recommended procedure to obtain the best results and greatest assurance of safe operation is the daily sampling and testing of feed and blowdown water, and of condensate from steam mains and surface condensers at the plant.

These tests are in turn to be checked by a qualified water chemist or steam engineer at frequent intervals and advice as to blow-downs and change in treatment is to be given when necessary.

C-226. In cases of severe priming and foaming, it is best to consult an experienced water-purification engineer about a remedy to be applied.

Care of Heating Surfaces

C-227. Where scale is being removed from boiler by the treatment of feed-water, it should be done under proper supervision so as not to bring the scale down too fast as it may accumulate on the sheets and within the tubes, causing bagging and blistering of these parts. The chemicals for this purpose shall be increased very slowly and the effect observed through tests of the blow-down water for excess chemicals.

In such cases the boilers should be taken out of service frequently for cleaning the rows of tubes exposed to the fire in water-tube-type boilers and for cleaning the shells of fire-tube types.

C-228. Care shall be used to prevent the entrance of oil into a boiler as it will collect in clots on the heating surfaces, causing bagging or rupture.

C-229. Where there is a possibility of oil entering the feed water through the use of condensed steam, provision in the way of suitable filters or chemical treatments should be made for its removal. Additional precautions should be taken in this removal through the location of suitable traps and drips on the exhaust-steam lines.

C-230. Discharge from heaters or heater coils for fuel-oil installations shall be wasted or diverted to other uses unless positive means are employed to safeguard the boiler against entrained oil.

*The rules were presented at a public hearing at the A.S.M.E. Spring Meeting in Milwaukee. On account of the length of the rules *Power* is printing them in short installments, of which this is the seventh.

C-231. Where boilers are taken off the line for cleaning and washing, they should not be blown down and opened up before the brickwork has been well cooled, otherwise the solid deposits may be baked on the heating surfaces, making the removal of these deposits difficult.

C-232. Where the feed water is being treated, boilers should be taken off the line at regular intervals, emptied, opened and given a thorough washing; to clear all tubes and heating surfaces of mud, slime and loose deposits.

C-233. Boiler tubes should be turbined as required, to free them from scale, but with proper feed treatment and control very little turbining should be necessary. Removal of scale from the exterior of fire tubes by vibrating them with an internal cleaner or hammer must be practiced with caution as it may cause a serious strain on thin tubes.

C-234. Soot should be removed from heating surfaces regularly. Where mechanical soot blowers are used the front tubes of some types of water-tube boilers should be blown and cleaned over the fire with a hand-operated steam or air lance. Care should be used to avoid any scouring by the hand lance on either tubes or tube sheets.

C-235. A competent and responsible person should make thorough inspection of the internal and external surfaces of the boiler at frequent intervals, logging the result of such inspections in detail to form a basis of comparisons from time to time. To forestall boiler corrosion, samples of boiler blow-down should be tested as required by Par. CA-3.

Internal Corrosion

Gases in Feed Water

C-236. Oxygen alone, or with carbon dioxide either in solution or mechanically mixed with feed water, are corrosive agents. Therefore these elements when present in objectionable quantity should be removed by such means as a well-vented open heater or some form of deaërator, deactivator, or by chemical treatment.

Other Causes

C-237. As a spray pond or cooling tower, when used in connection with surface condensers, constantly concentrates the impurities contained in the circulating waters, it is recommended that the makeup or unconcentrated water be used in the boilers where possible and not the waters from the spray pond or cooling tower.

C-238. Where a coagulant is used such as aluminum sulphate, care must be taken not to use an excess, retaining an alkalinity of at least 1 grain per gallon which will protect from corrosion.

C-239. Stray electric current is possible in power houses, giving rise to obscure electrolytic reactions in the boilers which will cause wasting away of boiler metal.

C-240. With a non-scale-forming water the use of similar metals is recommended. Care should be taken to keep coal, cinder, scale and chips of copper, brass and lead out of the boiler.

C-241. Loose mill scale should be removed from boilers, as it tends to promote electrolytic action and corrosion, especially where salt is present.

C-242. Defective circulation and unequal strains on members of the boiler structure tend to promote corrosion and must be checked where trouble is experienced.

C-243. Where pitting is experienced the surface of the metal should be cleaned carefully and the pits filled with zinc-oxide paste or other protective coating to check corrosive action.

Boiler Out of Service.

C-244. Where boilers are taken out of service for any length of time, cars shall be used to prevent corrosion. They should be emptied and then dried by means of hot-air stoves or light wood fire. An amount of quicklime in excess of 20 lb. for each 100 hp. of boilers should then be placed on boards in the interior of the boiler, after which the manheads and all connections on the boiler should be tightly blanked or closed.

C-245. Boilers shall, if idle for a considerable period, be opened up each three months for examination and the renewal of the quicklime, if necessary.

C-246. If idle boilers must be left with water in them in excess of a week, this water should first be boiled with the boiler properly vented for a short time to discharge all the gases possible from it, and then made alkaline in excess of 50 grains per gallon with caustic soda.

The weight of caustic soda required for this alkalinity shall be calculated as follows:

Rated Horsepower of Boiler $\times$ 0.7 = *Pounds of Caustic Soda*

The amount obtained is to be first dissolved and then introduced through the top manhead into a boiler full of water, after which the manhead and all connections to the boiler are to be made tight.

C-247. In cases where water must be kept in the boilers, a piece of bright clean iron or steel should be hung in the closed boiler in such a manner that it can be removed and inspected for rust or corrosion, at regular intervals.

C-248. Where boilers filled with water are idle long periods, great care should be used to keep this water cold, as the maximum amount of corrosion is promoted by lukewarm water. For this reason feed valves and all steam connections shall be tight at all times.

External Corrosion

Leaks

C-249. Boilers in service may be exposed to external leaks of different kinds which tend to corrode the shell. The operator shall guard against leaky safety valves and steam mains which drop condensation on the boiler and cause external corrosion, especially where the water runs under protective coverings.

C-250. Leaky manholes and handholes, particularly where ash and soot can collect, are especially dangerous as they corrode the shell rapidly. Such places shall be kept clean and tight.

C-251. The boiler operator shall periodically examine the blowoff pipe nipple when it is screwed into the mud drum or shell. Corrosion is liable to weaken the nipple at this point.

C-252. The roof over boilers shall be maintained in good condition, as roof water leaking down on settings tends to destroy them as well as to corrode the boiler itself.

C-253. Leaky tubes shall be rolled or replaced promptly to avoid possible corrosion of the tube sheet.

Boiler Out of Service

C-254. When the boiler is taken out of service it shall be cleaned externally and especial care taken to remove all wet ash and soot.

C-255. When a fire-tube boiler is to be out of service for a long period, the exposed portion of shell shall be given a coat of grease, red lead, black japan or tar paint to prevent external corrosion. The damper shall be closed and lime placed on several points in the setting to dry the air as much as possible. All openings into the setting shall be closed.

C-256. Where boiler has been taken off the line for an idle period, it shall be made certain that all feed and steam valves are shut and do not leak.

Erosion

C-257. Steam soot blowers shall be supplied with practically dry steam; they shall be well drained before using. Care shall be taken to prevent too direct an impingement with a steam jet upon the tubes and tube sheets, also on baffles.

C-258. In using a steam lance, care shall be taken not to blow with too much force or for too long a period upon any one point, particularly about the lower end of vertical water tubes.

Stresses Other than Internal Pressures

Failure of Supports

C-259. When boilers are set in a battery of two or more and the foundations are not tied together by reinforcement, the joints of connecting pipe lines shall be opened occasionally or other reliable means employed to check possible settlement.

C-260. Steel structures supporting boilers shall be examined periodically for fire hazards such as the near-by storage of inflammable materials.

C-261. Where structures surrounding boilers are designed to provide for expansion of the boilers, they shall be periodically examined in order to maintain the full amount of clearance provided.

C-262. On suspended type of settings care shall be taken to see that the load is properly distributed over all points of suspension.

C-263. Pipe-line supports and braces shall be examined periodically, and as far as practicable shall be maintained under their normal stress. Rollers in pipe-line supports shall be maintained in place and free to roll.

C-264. When stacks are supported from structures directly above the boilers or upon the boilers themselves, care shall be taken to maintain in satisfactory condition all safeguards installed for the protection of all steelwork against corrosion caused by water at this location running down on the stack or from the roof.

C-265. Supports for shafting and belting over boilers shall be maintained in good condition and periodically examined.

C-266. Supports of safety-valve escape pipes shall be maintained in good condition and under proper tension; they shall be examined periodically.

C-267. Where supporting columns are installed between settings or near boilers and are incased in concrete, the concrete shall be maintained in good condition and periodically examined. If the columns are exposed, they shall be kept well painted and the air space about them maintained free from accumulation of dirt, rubbish or other objectionable materials.

C-268. All structures over boilers, whether they are part of the boiler installation or building structure, shall be inspected periodically to see that corrosion does not occur, and shall be kept well painted at all times.

C-269. Supports of blowoff lines shall be maintained in good condition and in proper alignment and shall be examined periodically.

Mechanical Injuries

Tube Cleaning or Scaling

C-270. Power for operating mechanical hammers and cleaners used in removing scale or slag from fire-tube boilers shall be generated outside of the boilers being cleaned. When such tools are actuated by air, steam or water, they shall be operated at the lowest pressure sufficient to accomplish the work. When these tools are actuated by hot water or steam which exhausts within the tube, care shall be taken not to heat the tube to the extent of causing undue strains by expansion. Mechanical hammers and cleaners shall not be operated for more than a few seconds at a time at any one spot.

Loose Connections

C-271. The fastenings of all interior fittings such as braces, baffles, feed troughs, gratings, zinc baskets and dry pipes shall be maintained secure and free from lost motion.

Repairs

C-272. All repairs and replacements shall be subject to the rules for similar material and workmanship as given in the Power Boiler Section of the Code.

C-273. No repairs other than those of a minor or routine character, shall be made upon a boiler except upon and in accordance with the advice of authorized boiler inspectors as required in Par. A-53 of the Power Boiler Section of the Code.

C-274. All repairs shall be made as soon as possible, and a record of all repairs upon boilers and upon any equipment or auxiliaries affecting the safety of the boiler shall be kept. A record of all repairs deferred shall be kept, with the reason for their delay.

C-275. All leaks, however small, shall be traced to their sources, and the proper remedy not only to stop the leaks but to prevent their recurrence, shall be applied as soon as practicable.

C-276. Many casualties have resulted from the practice of repairing boilers, pipe lines and attachments under pressure, and such practice should not be allowed except in cases adjudged to be safe by a competent and responsible person.

C-277. The shell or drum of a boiler in which a typical "lap-seam crack" is discovered along a longitudinal riveted joint for either butt-seam or lap joints shall be permanently discontinued for use under steam pressure. By "lap-seam crack" is meant the typical crack frequently found in lap seams, which extends parallel to the longitudinal joint and is located either between or adjacent to rivet holes.

C-278. Cracks caused by flexure of the metal shall be repaired by removing the part affected and replacing it with a new part as directed by authorized inspector.

C-279. Where corrosion becomes dangerous or when cracks appear, the boiler shall be kept out of service until the affected parts have been repaired or replaced. No welding or patching shall be done except upon and in accordance with the advice of authorized boiler inspectors.

C-280. Where pits occur closely grouped or aligned and are deep enough to affect the strength of the material, the affected area shall be removed and repaired, as directed by an authorized inspector. Isolated pits, not affecting the strength of material, may be prevented from becoming serious by cleaning the pit carefully and electrically welding or by filling with zinc paint or other protective coating.

C-281. Leaking rivets shall be calked about the edge of the head, and if the leak continues, the rivet shall be removed and a new rivet put in. The following method of removing a rivet is recommended: The rivet head shall be centered and drilled to the depth of the head; a crosscut through the center of the head shall then be made with a cape chisel and the remainder of the head removed by breaking inward the remaining sections. The shank of the rivet shall be centered and drilled two-thirds of the way through with a drill $\frac{1}{4}$ in. smaller in diameter than the shank and driven out by a backing-out tool $\frac{1}{16}$ in. smaller in diameter than the drill hole. Before driving a new rivet, the rivet hole shall be made clean and free from burrs and sharp edges.

C-282. No attempts shall be made to tighten up a bolted joint by putting undue stress on the bolts. If a joint cannot be made tight without unduly stretching the bolts, the joint shall be opened and the cause of the poor joint determined and removed.

C-283. In tightening bolts, undue stress shall not be placed upon the bolt by sledging the handle of the wrench, by increasing the leverage of the wrench with a piece of pipe or by other means, as an average man with a 12-in. wrench will stretch a $\frac{5}{8}$-in. bolt; 18-in. wrench will stretch a $\frac{3}{4}$-in. bolt; 24-in. wrench will stretch a $\frac{7}{8}$-in. bolt; 30-in. wrench will stretch a 1-in. bolt. These represent the limits which bolts should be expected to stand.

C-284. In cleaning gaskets from finished surfaces, care shall be taken not to score or cut the surface.

C-285. When water tubes are sufficiently warped to prevent proper cleaning or inspection for soundness and cleanliness, no attempt shall be made to straighten them in place; such tubes shall be renewed.

C-286. A water tube with a series of bags closely connected shall be replaced. Bags on water tubes should not be set back unless permitted by authorized inspector. When the bag leaks or is abrupt with a tendency to pod or point to such an extent that there is an appreciable stretching of the metal or a possibility of scale or deposit collecting in the bag, the tube shall be renewed.

C-287. Excessive amount of rolling of tubes should not be permitted as it may cause dangerous reduction in the thickness of the tube, expansion of the tube hole, and overstressing of the metal.

C-288. Tubes in fire-tube boilers which have been rolled several times and still leak, may be improved temporarily by rolling and beading the tube and then inserting a tight-fitting internal ferrule of boiler-tube stock of a gage equivalent to that of the tube and of a length equal to three times the thickness of the tube sheet. The inner end of the ferrule shall be chamfered on the inner edge and the outer end shall be rolled and beaded after the ferrule is in place. There shall not be more than 10 per cent of the number of tubes in the boiler so equipped, and not more than two adjacent tubes at any one time.

C-289. Tubes of water-tube boilers shall not be re-ended or pieced by autogenous welding.

C-290. In removing tubes exceptional care shall be taken not to injure the metal around the tube hole. The following method of removing a tube is recommended: Beginning about $\frac{1}{2}$ in. inside of tube sheet, cut with a cape chisel a longitudinal slot about $\frac{5}{8}$ in. in width and 2 in. in length. Then insert a $\frac{1}{2}$-in. x 1-in. flat bar and lever the burr at the far end of the slot upward, increasing the length of the slot to about 4 in. Remove carefully the portion of the bead or bell in line with the slot and, with a round-nosed tool ground to the shape of the tube hole, cut away that portion of the tube between the slot and the outer end of tube. With a blunt tool drive inward the corners of the tube at the slot until the end of the tube is so crumpled that it will pass through the tube hole without injuring the tube sheet. At the other end of the tube, raise and bend inward with a blunt tool all the bead or bell so that the tube can be withdrawn without injury to the tube sheet.

C-291. When a new tube is to be installed, the surfaces of the metal about the tube hole shall be made free from any projections due to mutilation and shall be thoroughly cleaned of scale or foreign matter. Any grooves, scorings, or holes in these surfaces which will not permit the tube to be rolled to a tight joint shall be machined out or welded up and machined out. The ends of the new tube, where they come in contact with the tube sheet or header, shall be made clean and smooth before the tube is put in place.

C-292. The rolling or expanding of the tubes shall be done by a competent person. Before expanding a tube, the

expander shall be examined to see that it is equipped with the proper rollers, straight or tapered in the proper direction. Rolling shall be stopped when the rollers operate evenly all around the tube with sufficient pressure on the mandrel. The beading of a tube shall be done by rol'ers especially designed for the purpose or by a tapered mandrel driven into the end of the tube. The flaring, beading and welding of tubes and nipples and the amount of projection of the end of the tube beyond the tube sheet or header shall be in accordance with the rules given in Pars. P-250, P-251 and P-252 of the Power Boiler Section of the Code. The tube ends should be lightly rolled after beading or belling.

C-293. The rules applying to the care of tubes and the surfaces about the tube holes are equally applicable to the care of the nipples and the surfaces about the nipple holes.

C-294. In removing slag from the exterior surfaces of a boiler or its tubes, care shall be exercised not to injure the metal.

Boiler Explosion Statistics

At the recent meeting of the National Board of Boiler and Pressure Vessel Inspectors, E. W. Farmer, Inspector of Steam Boilers, State of Rhode Island, who has quite recently been appointed statistician of the Board, made a report in which was included some interesting figures on the explosions of boilers for the years 1922, 1923 and 1924 in the U. S. as follows:

EXPLOSIONS OF BOILERS FOR 1922

Explosions of power boilers, code			57	
Non-code			78	135
Explosions of heating boilers and pressure vessels				61
Accidents to power boilers, code			172	
Non-code			124	296
Total				492
Killed by power boiler accidents, code			42	
Non-code			79	121
Injured by power boiler accidents, code			194	
Non-code			133	327
Total				448
Killed by heating boilers and pressure vessels				14
Injured by heating boilers and pressure vessels				44
				58
Grand total				506
Accidents by mechanical devices other than boilers:				
Flywheel explosions	22	5 killed	4 injured	
Steam turbine explosions	6	1 killed	1 injured	
	28	6	5	

EXPLOSIONS OF BOILERS FOR 1923

Explosions of power boilers, code			39	
Non-code			80	119
Explosions of heating boilers and pressure vessles, code			24	
Non-code			44	68
Accidents to power boilers, code			106	
Non-code			139	245
Total				432
Killed by power boiler accidents, code			37	
Non-code			113	150
Injured by power boiler accidents, code			134	
Non-code			189	323
Total				473
Killed by heating boilers				3
Injured by heating boilers				13
Killed by pressure vessels				7
Injured by pressure vessles				18
Grand total				514
Accidents from other than power boilers:				
Flywheel explosions	26	5 killed	12 injured	
Steam-turbine explosions	4	..	3	
Steam-blower explosions	1	6	2	
Total	31	11 killed	17 injured	

EXPLOSIONS OF BOILERS FOR 1924

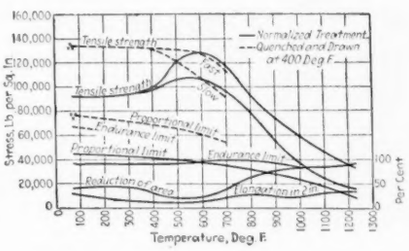
Explosions of power boilers, code			19	
Non-code			39	58
Explosions of heating boilers				33
Explosions of pressure vessels				12
Total				73
Accidents to power boilers, code			66	
Non-code			48	114
Grand total				187
Killed by power boilers, code			27	
Non-code			33	60
Injured by power-boilers, code			80	
Non-code			57	137
Total				197
Killed by pressure vessels				4
Injured by pressure vessels				24
Killed by heating boilers				8
Grand total				233
Accidents from other than power boilers:				
Flywheel explosions	28	10 killed	20 injured	
Other accidents	11	..	3 injured	
Total	39	10 killed	23 injured	

Normalized Steel Stronger at Blueing Temperatures

The solid lines in the figure show how the strength of steel which is annealed or normalized increases to a maximum at 600 deg. F., the region of blueing temperatures by both fast and slow tests, as brought out by J. McClean Jasper in a paper presented at the June 23-26 meeting of the A.S.T.M., at Atlantic City.

The proportional limit or highest stress where the relation of force applied to deformation produced is constant, was not raised with increasing temperatures. This shows that mechanical working of the testing process exerts its greatest effect during the yielding state of the material at these blueing temperatures, since at this region the tensile strength is most improved by working.

The strength of normalized steel at ordinary temperatures may be raised



Static and fatigue properties of a 0.50 carbon steel tested at elevated temperatures

to the points in the figure indicated by crosses, by means of stressing, while at blueing temperatures to 90 per cent of the short-time tensile strength.

Proper heat treatment however, may give equal strength at ordinary temperatures. The dotted line at the top is for steel quenched and drawn at 400 deg. F. Test results at 600 deg. are about equal to those for normalized steel. This indicates that there is no advantage in heat treatment if the metal is to be used at or above 600 deg.

The general trend of curves in the figure indicates that blueing temperatures are best for obtaining maximum strength through mechanical working. Such strength can be made to approach that obtained by the best heat treatment.

At temperatures above 600 deg. there is less and less difference in results of long and short time static tests. As temperatures are elevated a metal gradually loses its elastic properties and assumes a plastic state.

Samples of carefully constructed riveted joints, when placed in a testing machine, reveal considerable slip long before the working load of the joint is reached. Some slip is unavoidable, for although the rivets when hot may be set with great pressure to fill the rivet holes completely, there is shrinkage upon cooling, and when the friction between the plates is overcome, some slip or "take up" is necessary for the rivets to come to a bearing for resistance against shearing.

Recent Publications

Physics in Industry, Vol. 2. Lectures delivered before the Institute of Physics. Published by the Oxford University Press, American Branch, New York City. Cloth, 6x10 in.; 48 pages. Price, $1.

This volume contains lectures: "The Application of Physics to the Ceramic Industries," by J. W. Mellor, D.Sc.; "The Physicist in the Textile Industries," by A. E. Oxley, D.Sc.; "The Physicist in Metallurgy," by C. H. Desch, S.Sc.; Foreword by The Hon. Sir Charles A. Parsons, K.C.B.

Mechanics and Heat. (Second edition, revised and enlarged.) By William B. Anderson, Ph.D., professor of physics, Oregon State College. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Avenue, New York City. Cloth; 6x9 in.; 371 pages; 153 illustrations. Price, $2.50.

This second edition differs from the first only in minor details, including the addition of a few tables and illustrations. The nature of the subject is such that new developments cause little change in the principles or in the method of expounding them. Dealing with the fundamentals of mechanics and heat in a method suited to the needs of students of physics, this book requires no calculus or higher mathematics. The various subjects are presented in a clear and logical manner.

America's Greatest Dam. By William Benjamin West. Published by Frank E. Cooper, 235 Broadway, New York City, 1925. Cloth; 8x11 in.; 62 pages; 55 illustrations. Price, $2.

No water-power project in this country has created greater public attention than has that at Muscle Shoals. In this book the author has given a description of this project from its earliest conception down to the present, when the power plant at Wilson Dam is about ready to go into service. A description of the nitrate plants and the hydro-electric development is given as well as a résumé of the political entanglements that grew out of the government's attempts to dispose of the project. The book is written in a way that can be understood by the layman as well as by engineers, and it should fill a useful purpose to those interested in the project.

Superheat Engineering Data. Sixth edition revised. Published by the Superheater Co., 17 East 42nd St., New York City. Cloth; 4½ x 6¾ in.; 202 pages; 86 illustrations; numerous tables. Price, $1.

The value of this as an up-to-date reference book may be gaged from the number of pages, which are more than twice those of its widely circulated predecessor, the "Data Book for Engineers," fifth edition, and yet little has been retained from the former volume except some basic ideas and standard tables. Before tables, charts and other data are presented, a review of power-plant progress is outlined, with curves illustrating advances in temperature, pressure and other quantities. After the field of superheat application is briefly presented, come reference data on fuel, combustion, steam generation, piping problems and many other subjects with which the engineer at times must deal. Finally, typical boiler constructions are voluminously illustrated, and an ample index is included. For present-day steam-plant problems this is a desirable and practical collection of data.

Heat Engines. By John R. Allen and Joseph A. Bursley. Published by the McGraw-Hill Book Co., Inc., New York City. Cloth; 6x9 in.; 422 pages; 35 tables; 233 illustrations. Price $4.

Published originally in 1910 and first revised in 1914, this treatise on heat engines has been partly rewritten by one of the authors, Professor Bursley, in order to bring it up to date, the co-author, Professor Allen, having died since the first revision. It is primarily a textbook for engineering students, and as such its descriptive treatment of general types of power-plant equipment should prove adequate. Numerous problems supplement the text. In fact the reception of the two previous editions has well established the book in this field. The treatment, however, is not so well adapted to the requirements of the practicing engineer, except perhaps the chapter on thermodynamics, which is handled in an elementary manner and should suffice for review or reference. The inclusion of more performance data would have been highly desirable.

Power Switchboard and Switching Equipment Handbook. Published by the Electric Power Club, B. F. Keith Bldg., Cleveland, Ohio, 1925. Paper; 6x9 in; 95 pages; 40 illustrations. Price, 50 cents.

Part I of this book gives instructions for the installation, operation and care of power switchboards, oil circuit breakers and other switching equipment. Part II gives standard definitions as applied to electric power equipment in general, relays, miscellaneous switches, power switchboards, oil circuit breakers, and also abbreviations and graphic symbols are included. Part III treats of power switchboard and switching equipment standards. This includes rating standards, manufacturing practices, application practices, specifications, etc. Part IV deals with Electrical Safety Conference Standards and includes safety standards for switchboards, oil circuit breakers and oil switches. The book contains a great deal of valuable information for those interested in the design, purchase, installation and care of electric power switching apparatus and should find a wide field of usefulness with these classes of readers.

The Transactions of the First World Power Conference, London, June 30 to July 12, 1924. Published by Percy Lund Humphries & Co., Ltd., Three Amen Corner, London, E.C.4, England. 4 Vols. and Index. Cloth; 6½x10 in.; 5,500 pages. Price, Vol. 1-4, £12; Index, £2.

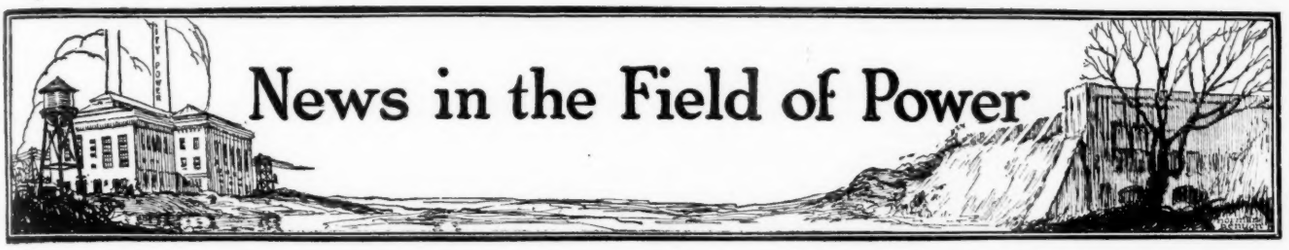
The Transactions include all the papers, approximately 320, presented at the Conference held at the British Empire Exhibition at Wembley, and also a synopsis of the discussions of papers and committees. To the papers written in the English language a résumé in French has been added, and of those in French and Italian a résumé in English is given.

Vol. 1 contains, "Power Resources of the World, Available and Utilized"; Vol 2—"Water Power Production, Preparation of Fuels, Steam Power Production"; Vol. 3—"Internal Combustion Engines, Gas and Fuel Section, Power from Other Sources; Power Transmission and Distribution, Standardization and Research, Illumination"; Vol. 4—"Power in Industry and Domestic Use, Power in Electrochemistry and Electrometallurgy, Power for Transport, Economic Aspects of Power Resources, Education Health Publicity."

Principles of Machine Design. By C. A. Norman, Professor of Machine Design in the Ohio State University; member of the American Society of Mechanical Engineers, member of the Society of Automotive Engineers. Published by the Macmillan Co., New York, 1925. Cloth; 6 x 8½ in.; 710 pages; 585 illustrations; 106 tables Price, $6.50.

The reason why DeLaval's turbine disks originally were not bored through for a shaft, why staybolts should be flexible, why Marten's formula for packing-gland leakage is especially useful, and many other such points appear throughout the book. It is because this volume of the Engineering Science Series is intended to impart to the student analytic reasoning on the basis of fact by supplying valid engineering rules illustrated by actual engineering results. It is intended to cater to the requirements of constructive thinking and engineering creation. The thirty-four chapters, including subjects such as riveting and welding, gearing, chains, brakes, etc., are well written and full of engineering reasons which should hold the students' interest by reason of the good information obtainable.

Annual Report of the Board of Regents of The Smithsonian Institution, showing the operations, expenditures and condition of the Institution for the year ending 1923. Publication 2758, Government Printing Office, Washington, D. C. The volume contains many technical papers beside the reports, among which, of interest to readers of *Power*, are: "The Utilization of Volcanic Steam in Italy," "Proposed Tidal Hydro-Electric Power Development of Petitcodiac and Memramcook Rivers," by W. Rupert Turnbull.



Cherokee Bluffs Plant Will Total 135,000 Hp.

The installation of waterwheel-driven generators in the new Cherokee Bluffs plant on the Tallapoosa River, Ala., of the Alabama Power Co. will total 135,000 hp. There will be three 45,000 hp. units, the largest in the Southern States. With the exception of those at Niagara Falls they will be the largest in the United States. All the generators are being furnished by the General Electric Co. Two of the waterwheels will be supplied by the Allis-Chalmers Manufacturing Co., and the third by the William Cramp & Sons Ship & Engine Building Co.

The generators are rated 37,500 kva., 88 per cent power factor, 120 r.p.m., 12,000 volt, three-phase, 60 cycle, vertical shaft, with direct-connected exciter and spring thrust bearings.

It is expected that the plant, which will be interconnected with the other plants of the company, will be completed during 1926.

The storage reservior will provide the greatest artificial lake in the world, with an impounding capacity of 530 billion gallons. Roosevelt Dam Reservoir, at present one of the largest artificial bodies of water, holds 420 billion gallons.

Examination for Junior Engineers

The United States Civil Service Commission has announced an open competitive examination for junior engineers to be held in any one of a large number of cities listed on the Civil Service Circular No. 197. The service will cover work in the Bureau of Construction and Repair, and the Bureau of Engineering of the Navy Department, the Bureau of Mines, the Bureau of Standards, Water Resources Bureau of the Geological Survey, Bureau of Public Roads, Forest Products Laboratory and the National Advisory Committee on Aeronautics. At present there are five vacancies in the Bureau of Construction and Repair of the Navy Department to be filled from this examination.

The duties will cover such work as routine testing, inspection of engineering materials, drawing up plans for minor projects, preparing specifications, making computations, assisting in experimental research work and compiling reports. The entrance salary in the District of Columbia is $1,860 a year with provision for advancement without change in assignment up to $2,400 a year. Application should be made to the United States Civil Service Commission, Washington, D. C., before Aug. 8, 1925.

Canada to Manufacture Coke on Large Scale

Within the next few weeks large government coke ovens are to be constructed in Windsor, Ont., it is reported. C. P. Hotchkiss, Dominion Secretary of the Government Fuel Board, recently made a survey of the fuel situation throughout Canada, and the recommendation was made that the establishment of coke ovens should be undertaken at once.

The government will manufacture coke, artificial gas, benzol and other byproducts, which will be sold to the consumer at cost. Mr. Mitchell, mayor of Windsor, stated: "This will bring about a sharp reduction in fuel prices. In the past citizens have had trouble obtaining fuel of any kind at reasonable prices, and many times anthracite could not be bought at any cost." Anthracite valued at more than $44,000,000 was imported by Canada from the United States last year. A coking plant would use native coal.

Pit River No. 3 Placed in Service

The latest hydro-electric development of the Pacific Gas & Electric Co., Pit River No. 3, was formally dedicated and placed in operation on July 17 with a fitting ceremony which was witnessed by over 250 editors and other guests of the company. The party occupied a fourteen-car special train on the two-day excursion from San Francisco, which included a stop at Mt. Shasta, thence over the McCloud River Railroad and the company's construction railroad to the plant.

The new station contains three 30,000-hp. vertical reaction turbines operating under a head of 280 ft., and is tied in with the other plants of the system. The development was started about two years ago and was completed at a cost of thirteen and a half million dollars.

The Province of Alberta, Canada, has recently passed an act respecting the sale of coal, known as "The Coal Sales Act, 1925." The bill puts into statutory form regulations made under the Coal Sales Act and requires that all Alberta coal shall have a registered trade name and shall be advertised or sold only under such name. It further requires that all documents referring to coal shall state the area or district from which the coal comes and the size of the coal, gives powers of inspection and other powers for the purpose of ascertaining whether coal is being sold or shipped under a correct description, and provides penalties for false statements and failure to make statements.

Uinta Basin Utah Water Power Resources Reported

The "Water Supply of Uinta Basin and Its Utilization," is the title of a recent report of an investigation made by the United States Geological Survey under the direction of Ralf R. Woolley, hydraulic engineer and the late C. C. Jacob, for several years water master in the Uinta Basin, Utah.

The report shows that at 16 sites on the streams within the basin the potential power of existing flow of an overall plant efficiency of 70 per cent is about 56,000 hp. for 90 per cent of the time and about 110,000 hp. for 50 per cent of the time. This power can be increased considerably by providing storage to supplement low-water flow and the report describes reservoir sites that can be utilized for that purpose. The report is available for inspection at the Interior Department, Washington, D. C., or at the Geological Survey office at Salt Lake City, Utah.

Mechanical Stokers Sold Jan.-June, 1925

The Department of Commerce announces the following statistics on Mechanical Stokers for the month of June, 1925, compiled from reports received from 13 establishments:

STOKERS SOLD, HEATING SURFACE, AND KINDS OF INSTALLATION

Year and Month	Establishments Reporting, Number	Stokers Sold, Number	Installed Under Fire-Tube Boilers: Number	Installed Under Fire-Tube Boilers: Sq.Ft. Heating Surface	Installed Under Water-Tube Boilers: Number	Installed Under Water-Tube Boilers: Sq.Ft. Heating Surface
1925						
June	13	128	26	46,250	102	394,700
May	13	122	23	39,340	99	516,540
April	13	120	23	58,930	97	417,340
March	13	131	17	24,460	114	686,530
February	13	135	28	49,050	107	413,930
January	13	57	4	8,700	53	270,010

Holtwood Steam Plant Starts Operation

The new 30,000-kw. steam station recently completed for the Pennsylvania Water & Power Co., adjacent to its hydro-electric development at Holtwood, Penn., was formally opened on July 15. The new station burns powdered coal and the initial installation consists of two 15,000-kw. units with provision for extension to an ultimate capacity of 150,000 kw. It will supplement the hydro power and is intended to carry part of the base load.

Controlling Seasonal Slumps

The business bugbear, "Seasonal Slump," which ejects thousands of employees from work periodically and ties up an infinitely large amount of capital, has been the subject of an investigation by the Policy Holders' Service Bureau of the Metropolitan Life Insurance Co. The results of the investigation have just been published in a pamphlet entitled, "Studying Business," which describes several effective methods of controlling seasonal slumps as employed successfully by a number of companies in various industries. Among the methods suggested are:

1. Dovetailing side lines with the regular product, or the dovetailing of special products within the regular line.
2. Transferring employees from one process or department to another within the plant without introducing new products.
3. Producing for stock. The movement for standardization sponsored by many trade associations and urged by Mr. Hoover has helped materially in influencing plant managers to manufacture for stock.
4. In lines not subject to deterioration or sudden shifts of fashion, many have found it advantageous to manufacture for advance orders.
5. The seasonal discount has been helpful in some industries in encouraging jobbers to increase their stocks.
6. Seasonal advertising.

Subsequent pamphlets on stabilization as applied to specific industries are now in preparation. Dr. W. A. Berridge, economist in charge of the Research Section of the Bureau, has announced that more than sixty companies have already contributed their experiences to this pool of information, and others who have had experience in this line are invited to co-operate.

Netherlands Buys American Machinery

Sales of American power-generating machinery to the Netherlands increased from $16,054 in 1923 to practically double that figure in 1924.

The Netherlands was the leading buyer of German internal-combustion engines among the countries of the world in 1924 and also of pumps, elevators, blowing and ventilating machinery, although sales of all these items were considerably less than in 1923. A heavy decline, however, in sales of all types of German power-generating machinery to the Netherlands occurred in 1924. In 1922 and 1923 that country ranked first among Germany's markets for certain classes of this machinery and second in other power-generating equipment items, but in 1924 there were no exports of this machinery to the Netherlands listed in German statistics.

The following table gives United States exports of power generating and allied machinery to the Netherlands during 1922, 1923 and 1924:

UNITED STATES EXPORTS OF POWER-GENERATING MACHINERY TO THE NETHERLANDS

Class	1922	1923	1924
Power-generating machinery, except electric	$49,416	$16,054	$34,626
Construction and conveying machinery....	11,741	160,808	41,313
Mining, oil well, and pumping machinery..	29,193	51,286	139,186

Quebec Power Site to Develop 1,000,000 Hp.

According to reports in the press the Price Brothers Paper Co. has disposed of its rights in the Chute-a-Caron power site in Quebec to the Duke-Davis interests for between $5,000,000 and $6,000,000. Chute-a-Caron is in the Lake St. John district, where James B. Duke has been making large developments for power distribution. The Aluminum Corp. of America is planning a large industrial plant in connection with the project.

The Duke-Davis interests plan to develop 800,000 hp. on this site, which is below the Duke-Price plant, whose development is 360,000 hp., bringing the total capacity to more than 1,000,000 horsepower.

The Price Brothers Co. will take 200,000 hp. from the Duke-Price Company by 1927, when it is expected that their production of newsprint will have reached a total of 800 tons a day. The Aluminum Corporation's plant will also require a large amount of power.

Financing for the development has been done in the New York market. Estimates on another project, the Carillon development of the financing sought for have been between $40,000,000 and $50,000,000, but no effort to get a loan here has been made. Bankers are said to be waiting for a clearer situation with regard to the power export problem.

A.S.M.E. Selects Altoona for Regional Meeting

Announcement has just been made by the American Society of Mechanical Engineers of plans for a regional meeting to be held in Altoona, Pa., Oct. 5-7.

Inasmuch as the technical program will treat largely of transportation problems, the selection of Altoona is especially fitting, as it will afford opportunity for an inspection trip through the vast shops of the Pennsylvania railroad. A feature of these shops is the testing plant in which the test table permits the operation of a locomotive at a speed of eighty miles an hour and contains all the instruments and apparatus to measure and record every part of the effort.

Meritorious Service Award Established

The United Gas Improvement Co., of Philadelphia, has announced the founding of an award to be conferred for "extraordinary effort without regard to self" for maintaining uninterrupted service or toward restoring interrupted service, or in some manner indicating exceptional fidelity to the public interest by employees of public utilities.

It is to be known as the Samuel T. Bodine Meritorious Service Award in honor of the president of the Company, and employees of all public-utility companies controlled by the U.G.I. will be eligible.

Personal Mention

Col. H. C. Boyden, of Chicago, has been appointed dean of the engineering department of the Ohio Northern University, Ada, Ohio.

A. A. Heller, treasurer and general manager of the International Oxygen Co., Newark, N. J., returned recently from an extensive trip abroad.

Business Notes

The Chicago Fuse Mfg. Co., Laflin & 15th St., Chicago, Ill., has moved its Philadelphia office from the Weightman Bldg., to 517 Packard Bldg.

The Scott Valve Manufacturing Co., Detroit, Mich., announces the appointment of H. P. Rodgers & Co., Leader-News Bldg., Cleveland, Ohio, as its Cleveland representative.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio, announces that the Uhrich Supply Co., 914 Central St., Kansas City, Mo., is representing it in that territory.

The Republic Flow Meters Co., Chicago, Ill., announces that it is opening a factory branch office in Buffalo, N. Y., which is to be in charge of W. W. Barron.

The Reading Iron Co., Baer Bldg., Reading, Pa., announces the appointment of R. L. M. Taylor, formerly with the A. M. Byers Co. and for a year connected with the Reading Iron Co., as district representative for the New York and eastern Pennsylvania territory.

The Strom Ball Bearing Mfg. Co., 4527 Palmer St., Chicago, Ill., announces the appointment of Frank R. Schubert as general manager and of John Diesk as works manager, succeeding Mr. Schubert, also that Lorenz Peterson continues as assistant works manager in charge of production.

McClellan & Junkersfeld, Inc., engineers and constructors, of New York, St. Louis and Washington, D. C., are now represented in Chicago by Stephen Gardner, as district manager, with offices at 203 South Dearborn St., Chicago. Mr. Gardner will continue also as president of the Industrial Engineering and Sales Service, Inc., of Chicago.

The Ideal Commutator Dresser Co., Sycamore, Ill., has opened a new branch office at 421 Fulton Bldg., Pittsburgh, Pa., where a stock of commutator resurfacers and wire connectors will be carried for emergency purposes. R. F. Waldo, for many years connected with the New York office of the company has been appointed the district sales engineer.

The General Electric Co., Schenectady, N. Y., announces that Robert Miller has been appointed manager of the Rocky Mountain sales district, with

headquarters at Denver, Colo., succeeding Harry D. Randall who is on leave of absence because of ill health. B. J. Wheatlake succeeds Mr. Miller as local office manager at Salt Lake City. Mr. Randall has been assigned to special duty at Schenectady.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces the creation of a new meter section. R. T. Pierce, formerly of the supply engineering section, will be in charge at Newark, N. J., where indicating, portable and recording instruments and relays are manufactured. The instrument transformers are manufactured at Sharon, where an assistant to Mr. Pierce will be stationed. S. A. Berger, Newark manager of the meter section, will remain as manager of the section and will handle the company's electric meters.

The McClave Brooks Co., Scranton, Pa., announces changes in its sales organization as follows: I. R. Hoffman, formerly of the Philadelphia district office, recently became district manager of the Scranton territory with headquarters at the main office of the company; Stephen A. Brooks became manager of the New York district territory with headquarters at 1440 Broadway; J. C. Stewart, the present assistant district manager, will retain his present position there; Harlan W. Bird will resign his duties as manager of the Chicago district, and J. P. Greenwood, formerly state engineer for Texas, will take charge of that terrritory on August 1.

Trade Catalogs

Valves—Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa. Bulletin 7E describes Everdur valves, fittings and jets and includes cross-sections of this equipment.

Instruments, Recording—The Bristol Co., Waterbury, Conn. Bulletin No. 332 shows the new models of electrical recording instruments which supersede those in the previous catalog.

Condulet — Crouse-Hinds Co., Syracuse, N. Y. Bulletins No. 2068 and No. 2076 describe the screw cover junction condulets, which are made in two diameters, 2½ and 3½ in.

Trap, Steam—The W. B. Connor Co., Inc., 223 West 33rd St., New York City. Catalog "A" covers the action and construction of the "Ace" Corliss valve steam trap. Copies may be had upon request.

Coal Handling Equipment — Conveyors Corporation of America, 326 Madison St., Chicago, Ill. A bulletin has recently been received which describes the American mono-rail cable conveyor manufactured by this company.

Tests, Evaporative—Combustion Engineering Corp., Broad St., New York City. A "Report of Evaporative Tests on Boiler No. 1, Power House No. 1 of the River Rouge Plant of the Ford Motor Co.," has recently been issued. It contains tables and illustrations and drawings of the equipment.

Coming Conventions

American Chemical Society. Charles L. Parsons, 1709 G St., N. W. Washington. Meeting at Los Angeles, Aug. 3-8.

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn Meeting at Salt Lake City, Aug. 31-Sept. 3.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Minnesota Association** at St. Paul, Aug. 24-28. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Universal Craftsmen Council of Engineers. Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Twenty-third international convention in the Armory, at Akron, Ohio, August 4-8.

Strainers—Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa. Bulletin 9M, "Magnetic Oil Strainers," covers strainers for lubricating oil used in the bearings and speed-reduction gears of steam turbines and internal-combustion engines and includes a price list and capacity table.

Boilers — Southwestern Engineering Corp., 1221 Hollingsworth Bldg., Los Angeles, Calif. "Collins Water Tube Boilers and Southwestern Heating Boilers," covers description and the installation of these curved water tube boilers. The portable type in 80 hp. size is also shown accompanied by pictures and drawings.

Stokers—Detroit Stoker Co., General Motors Bldg., Detroit, Mich. The new catalog "Detroit Stokers," gives illustrations and descriptions of the construction and operation of the underfeed stokers, both single and multiple-retort types, manufactured by the company, and shows numerous pictures of installations in various industrial and public plants.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	July 20, 1925
Pool 1	New York	$2.40@$2.70
Smokeless	Boston	4.20@ 4.35
Clearfield	Boston	1.59@ 1.90
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.40@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.10@ 1.25
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—July 23, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b., Bayonne, N. J.

St. Louis—July 14, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., 5.25c. per gal.

Pittsburgh — July 15, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—July 21, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia—July 16, 28@30 deg., $2.205@$2.268 per bbl.; 18@22 deg., $1.932@$1.985; 13@16 deg., $1.68@$1.743 per bbl.

Boston—July 20, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati — July 20, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5⅜c. per gal.; 30@32 deg., 5⅝c. per gal.

New Plant Construction

Ala., Birmingham — L. B. Camp, 1115 American Trust Bldg., is in the market for a 350 hp. Corliss engine (used).

Ala., River Falls—Southern Engineering Corporation, Albany, is in the market for six 200 kva., 44,000-2,300 v. single ph., oil cooled transformers.

Ark., Searcy—J. P. Walkins and S. K. Davis, plan the installation of a 100 hp. oil engine, in cotton gin. Continental Gin Co., Title Guarantee Bldg., Birmingham, Ala., is engineer.

Calif., La Canada—La Canada Irrigation Dist., will receive bids until August 4th for (a) one multistage direct-connected centrifugal pump, 450 g.p.m. capacity; (b) one multistage direct-connected centrifugal pump, 360 g.p.m. capacity. H. Hawgood, 722 H. W. Hellman Bldg., Los Angeles, is engineer.

Calif., Modesto—Reclamation Dist. No. 2031, Dennett & Zion, representatives, has had plans prepared for the construction of a pumping plant including two vertical sewage pumps 9,500 g.p.m., driven by 30 hp., 860 r.p.m., 440 v. capacity motors. Estimated cost $14,285. Ohm & Raab, 517 East Market St., Stockton, are engineers.

Calif., Needles—City is having plans prepared for one 700 g.p.m. vertical centrifugal deep well pumping unit; one 700 g.p.m. horizontal centrifugal pump and motor, etc. Burns-McDonnell, Smith, Marsh-Strong Bldg., Los Angeles, are engineers.

Calif., San Francisco — City and San Francisco County, are having preliminary plans prepared for equipment, including compressors, blowers, motors, electric locomotives, power sub-stations, etc., for Hetch Hetchy Aqueduct, etc. Estimated cost $210,479. M. M. O'Shaughnessy, is city engineer.

Calif., San Francisco — Pacific Gas & Electric Co., 246 Market St., has had plans prepared for the construction of a boiler plant and generator building at Maryland and Humboldt Sts. Estimated cost $60,000. Company engineers in charge.

Conn., Meriden—Connecticut School for Boys, will receive bids for plans for power house, etc., for boys school. Estimated cost $120,000.

D. C., Washington — The Washington Central Trust Co., plans the construction of a 10 story office building at 15th St., New York Ave. and G. St. Estimated cost $5,000,000.

Fla., Arcadia—City Council, D. G. Barnett, Pres., will receive bids until August 11th for improvements to water works and sewage systems including 1 duplicate set sewer pumps, tank on tower, etc. J. B. McCrary Engineering Corporation, Atlanta, Ga., is engineer.

Fla., Bartow—City will receive bids until August 12th for 2 water tube boilers and superheaters; 2 boiler pumps; one 1,000 kw. turbine driven generating unit; two 1,000 g.p.m. low head centrifugal pumps, one 1,500 g.p.m. high head centrifugal pump, two 600 hp. Diesel engines, etc. E. V. Camp & Associates, are engineers.

Ga., Warwick—Crisp County plans the construction of a 14,000 hp. hydro-electric plant on Flint River, here. Will install two 3,500-hp. single runner units. Southern Engineering Corporation, Albany, are engineers.

Ill., Galesburg—Chicago, Burlington & Quincy R.R. Co., 547 West Jackson Blvd., Chicago, awarded contract for the construction of a power plant to G. A. Johnson & Sons, 1335 North Clark St. $133,234.

Ill., Peoria—E. C. May & Hotel Co., will receive bids about August 10th for the construction of a 12 story hotel including refrigeration system, heating and lighting equipment, etc., at Main and Madison Sts. Estimated cost $1,500,000. Hewitt & Emerson, 1600 Peoria Life Bldg., and H. Trumbauer, Land Title Bldg., Philadelphia, Pa., are architects. Engineer not selected.

Ind., Indianapolis — Chamber of Commerce, awarded contract for the construction of a 10 story office building to T. A. Moynahan Construction Co., Ambassador Hotel. Estimated cost $1,500,000.

Ia., Des Moines — The Shrine Temple Building Assn., 720 6th Ave., will receive bids until August 3rd for the construction of a 3 story temple building with steam heating system, at 9th and Pleasant Sts. Estimated cost $1,000,000. Sawyer & Watrous, 401 Hippee Bldg., are architects.

Kans., Greenburg — City, A. C. Reed, Clk., voted $50,000 bonds for improvements and extensions to electric light plant.

Mass., Boston—Boston Elevated Railway Co., Park Square Bldg., awarded contract for the construction of addition to boiler house, etc., to John McDonald Construction Co., 77 Summer St. Estimated cost $50,000.

Mich., Detroit—L. Kamper, 3729 Cass Ave., Archt., awarded contract for the construction of a 10 story hotel, including steam heating equipment at Seward and Woodward Aves., to Otto Misch Co., 159 East Columbia St. Estimated cost $500,000. Owner's name withheld.

Mo., Bagnell—Missouri Hydro Electric Co., awarded contract for the construction of a power plant 75,000 hp. capacity including a dam, 2,450 ft. long and 140 ft. high with a 2,500 ft. spillway, to Bickel Construction Co., 1016 Baltimore St., Kansas City. Estimated cost $10,500,000.

N. Y., New York—Dept. of Public Welfare, Municipal Bldg., will receive bids until August 5th for the construction of Bronx General Hospital at 167th St. and Walton Ave. Also separate bids on heating and ventilating systems. Estimated cost $3,200,000. Private plans.

N. Y., New York—M. E. Gossett, c/o C. B. Meyers, 31 Union Square, Archt., is having plans prepared for the construction of a 16 story loft building including steam heating system at 8th Ave. and 35th St. Estimated cost $2,000,000.

N. Y., New York—Jatison Construction Co., Inc., c/o Schwartz & Gross, 347 Madison Ave., Archt., are having plans prepared for the construction of a 15 story apartment at 101 East 83d St. Estimated cost $2,000,000.

N. Y., Olean — Common Council, A. E. Turner, Clk., will receive bids until August 6th for the construction of a sanitary sewer system and pumping station with 2 centrifugal pumps and 2 gasoline engines. H. B. Cleveland, 38 Park Row, New York City, is consulting engineer.

N. Y., Syracuse—Chemical Toilet Corporation, 811 Free St., is in the market for a power press 48 in. between uprights (used).

N. C., Durham—Mayor and Council, R. W. Rigsby, Mgr., will receive bids until August 4th for the construction of extension to filtration plant including 3 motor driven low head centrifugal pumps 200 to 7,000 g.p.m. capacity. W. M. Piatt, is engineer.

O., Cleveland—City, A. K. Hoare, Comr. of Purchases, will receive bids until July 31st for one motor driven circulating pump for a 17,000 sq.ft. surface condenser; also for nine 500 kva single ph. 11,000 to 23,000 oil insulated self cooled power transformers.

O., Cleveland—Marine Hospital, c/o L. P. Bahrenburg, East 9th St. and Lakeside Ave., is having plans prepared for the construction of a 1, 2 and 3 story hospital, power house, etc. at East 124th St. and Fairmont Road. Estimated cost $1,000,000. J. A. Wetmore, Washington, D. C., is architect.

Okla., Apache — City is having preliminary plans prepared for the installation of a triplex pump and motor, etc., for waterworks. Estimated cost $15,000. Engineer not selected.

Okla., Carter—City, G. C. Mitchell, Clk., plans an election soon to vote $20,000 bonds for the construction of a new waterworks system including pumps, motors, tank on tower, etc. Engineer not selected.

Okla., Dewey—City is having preliminary plans prepared for well with a triplex pump and motor for waterworks system. Estimated cost $20,000. Engineer not selected.

Okla., Okmulgee — Okmulgee Wholesale Grocery Co., awarded contract for the construction of a 1½ story refrigerating plant to Smith & Senter. Estimated cost $40,000. Armour & Co., is lessee.

Pa., Meadville—City, D. Andrews, Clk., will receive bids until August 11th for the construction of a sewage pumping station, with compressors, etc. R. L. Phillips is city engineer.

Pa., Philadelphia—Treasury Dept., Office Superv. Archt., Washington, D. C., will receive bids until August 7th for the remodeling of a steam engine in the U. S. Post Office and Court House building here. J. A. Wetmore, is acting supervising architect.

Tex., Denton—North Texas State Teachers College c/o R. L. Marquis, is having plans prepared for the construction of addition to heating plant including 2 high pressure boilers. Estimated cost $40,000. H. J. P. Vitz, is engineer.

Tex., Houston—Turning Basin District Navigation Dist., H. L. Washburn, County Auditor, awarded contract for the construction of a grain building 1,200,000 bushel capacity to Fegles Construction Co., 706 First Ave., North, Minneapolis, Minn. $1,030,000.

Tex., Lockhart—Texas Power & Light, Interurban Bldg., Dallas, is having plans prepared for improvements to waterworks system here. Estimated cost $20,000. J. B. Hawley, Cotton Exchange Bldg., Fort Worth, is engineer.

Tex., Loraine—City plans an election August 11th to vote $30,000 bonds for improvement to waterworks system including additional pumping equipment, mains, etc.

Tex., Lubbock — City, E. R. Friend, Mayor, will receive bids until August 6th for 3 motor driven pumping units, (Contr. 15) 1,000,000 gal. reservoir, (Contr. 16) etc. Hawley & Roberts, Cotton Exchange Bldg., Fort Worth, are engineers.

Tex., Marshall—East Texas Public Service Co., O. Kennedy, Pres., plans the construction of addition to power plant. Estimated cost $200,000. Company engineers in charge.

Tex., San Antonio—San Antonio Amusement Co., W. J. Lytle, will soon receive bids for the construction of a 5 story theatre building on Houston St. Estimated cost $1,500,000. Boller Bros., Douglas Bldg., Los Angeles, are architects and engineers.

Tex., San Antonio—San Antonio Water Works, B. L. Raborn, plans installation of pump capable of keeping a 50,000 gal. stand pipe full. I. Ewig is engineer.

Tex., Temple—Temple Ice & Refrigerating Co., 401-409 South 2nd St., awarded contract for the construction of an ice plant on West Avenue A. to Love Construction Co. Estimated cost $100,000.

Tex., Wichita Falls—Brinker Ice Co., c/o E. Brinker, Sulphur Springs, plans the construction of a 40 ton capacity motor driven ice plant here. Estimated cost $100,000. Private plans. Owner will purchase equipment.

Wis., Alverno (Manitowoc P. O.)—Holy Family Convent, Alverno Route 1, Manitowoc, is having preliminary plans prepared for the construction of a boiler house with a high pressure boiler. Estimated cost $40,000. E. Brielmaier & Sons 432 Broadway, Milwaukee, are architects.

Wis., Janesville—Wisconsin Power & Light Co., Gay Bldg., Madison, awarded contract for the construction of a power plant here to Ford Construction Co. Estimated cost $40,000.

Wis., Prairie du Chien — City, W. A. Beuthen, Clk, plans the construction of a power plant. Engineer not selected.

Ont., Cochrane—Abitibi Power & Paper Co., Iroquois Falls, has purchased the Island Falls Hydro Electric Plant, Island Falls, on the Abitibi River and awarded contract for power house extensions to Fraser Brace Co., Ltd., 63 Craig St., Montreal, the installation of two additional units each consisting of a 12,000 hp. vertical turbine direct connected to 12,500 kva. generator to Dominion Engineering Co., Lochine, Que. Estimated cost $200,000 to $250,000.

Ont., Ottawa — Ontario Hydro Power Comn., A Beck, 190 University Ave., Toronto, plans the construction of hydro electric developments to generate 300,000 to 400,000 hp. on Ottawa River at Roche Fenders Rapids, Chenaux Rapids, Chat Falls, Deschenes Rapids, Carillon Rapids including the fall in the river at Point Fortune and Hawkesburg. Estimated cost $20,000,000. Development has been authorized by Ontario Government.

Que., Chelsea—International Paper Co., 100 East 42nd St., New York, is having plans prepared for the construction of a new power plant including a 100 ft. dam and two large power units one of 24,000 hp. capacity while another of equal capacity will be constructed later.

Ont., Toronto—Capitol Silver Mines Ltd., 602 Standard Bank Bldg., H. G. Laut, Pres., is in the market for pumps, etc.